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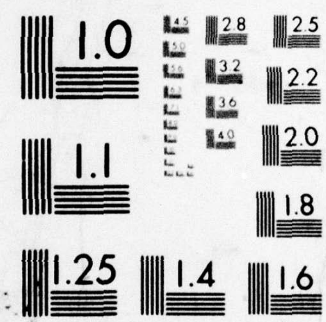
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Final Report

REQUIREMENTS AND ALTERNATIVE DESIGNS FOR AUTOMATING THE PUBLICATION OF NAVSEA MOTD AT THE NSDSA

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The United States Navy is currently in the initial phase of the Navy Technical Information Presentation Program (NTIPP), which is intended to modernize the generation, maintenance, publication, and distribution of MOTD on a Navy-wide basis. At the same time, NAVSEA, with an extremely large MOTD production requirement, is in the process of improving its own production capabilities. One of the NAVSEA MOTD production facilities is located at the NSWSES, Port Hueneme, California. The facility is used to support the NSDSA activities there, as defined by NAVSEAINSTS 5600.7 and 5600.8. These activities are quite extensive, dealing with the

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management of MOTD production from the definition of the original data requirements to the final distribution of the required documents to the Fleet. This report analyzes the ability of the current NSDSA publication support system (ADPREPS) to supply those requirements, and the alternative technical approaches that might be used to satisfy the NSDSA's growing requirements in the near future. The near future is defined as a period three to four years after the issuance of this report. The investigations were all placed within the context of the NTIPP. The manner in which the NSWSES publication system modernization program will be compatible with the later NTIPP developments was a major consideration.

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GLOSSARY

ACEF	-	Analysis/Cost Estimating Form (NAVSEA Form 5600/3)
ACN	-	Advance Change Notice
ADPREPS	-	Automated Document Preparation System
ADS	-	Automated Data System
ASPR	-	Armed Services Procurement Regulations
bpi	-	bits per inch
CASREPT	-	Casualty Report
CBC	-	Construction Battalion Center
CDRL	-	Contract Data Requirements List
CIIF	-	Configuration Item Identification File
CNO	-	Chief of Naval Operations
CONAR	-	Commanding Officer's Narrative Report
CPP	-	Contract Pricing Proposal
CPU	-	Central Processor Unit
CSTOM	-	Combat System Tactical Operational Manual
CSA	-	Configuration Status Accounting
CRC	-	Camera Ready Copy
CRT	-	Cathode Ray Tube
DDL	-	Data Distribution List
DID	-	Data Item Description
DRBB	-	Data Requirement Review Board
DSA	-	Design Service Allocation
DTNSRDC	-	David W. Taylor Naval Ship Research and Development Center
ECA	-	Engineering Change Authority
ECP	-	Engineering Change Proposal
EIB	-	Electronic Information Bulletin
EIC	-	Engineering Identification Code
EOSS	-	Engineering Operational Sequencing System

FACSO	-	Naval Facility Engineering Command FACilities Systems Office
FCB	-	Field Change Bulletin
FLD	-	Fault Logic Diagram
FLTAC	-	Fleet Analysis Center (Corona, California)
FOMIS	-	Fitting Out MIS
FOMM	-	Functionally Oriented Maintenance Manual
FPSR	-	Forms/Publications Status Report (NAVSUP Form 1088)
FRC	-	Federal Record Center
GOR	-	General Operational Requirements
HCL	-	Hardware Configuration List
HME	-	Hull, Mechanical and Electrical
IMRP	-	Integrated Maintenance Requirements Plan
IPB	-	Illustrated Parts Breakdown
IPR	-	In-Process Review
ISEA	-	In-Service Engineering Agent
ITIES	-	Interservice Technical Information Exchange System
JPA	-	Job Performance Aids
MDCS	-	Maintenance Data Collection System
MEA	-	Maintenance Engineering Agent
MEAR	-	Maintenance Engineering Analysis Report
MIP	-	Maintenance Index Page
MIS	-	Management Information System
MOC	-	Major Ordnance Configuration
MOTD	-	Maintenance and Operator Technical Data
MRC	-	Maintenance Requirements Cards
MUX	-	Multiplexer
NADL	-	Navy Authorized Data List
NAVELEX	-	Naval Electronics Command
NAVMAT	-	Naval Material Command
NAVSEA	-	Naval Sea Command
NAVSEC	-	Naval Ship Engineering Center
NOS	-	Naval Ordnance Station
NPFC	-	Naval Printing and Forms Center (Philadelphia)

SLD	-	Ship Logistics Division
SLM	-	Ship Logistic Manager
SMS	-	Ship Missile System
SMT	-	System Maintenance Test
SMT	-	Shipboard Microfiche Test (Program)
SNDL	-	Standard Navy Distribution List
SOR	-	Specific Operational Requirement
STEDMIS/ STEPS	-	Ship Technical Data MIS/Ship Technical Publications System
SWAPS	-	NAVSEA Ship Workload & Priority System
TAB	-	Training Aid Booklet
TDI	-	Technical Data Index
TM	-	Technical Manual
TMCR	-	Technical Manual Contract Requirement
TMDER	-	Technical Manual Deficiency/Evaluation Report
TMI	-	Technical Manual Indices
TMMP	-	Technical Manual Management Program
TMSR	-	Technical Manual SEATASK Requirement
TMSS	-	Technical Manual Specification & Standards
TYCOM	-	Type Commander
VC	-	Validation Certificate (NAVSEA Form 5600/4)
VDDR	-	Verification Discrepancy/Disposition Record (NAVSEA Form 5600/5)
VDT	-	Video Display Terminal
VIC	-	Verification Incorporation Certificate
WBS	-	Work Breakdown Structure
WEL	-	Weapons Equipment List
3-M	-	Ships' Maintenance and Materiel Management

EXECUTIVE SUMMARY

The United States Department of the Navy has embarked on an ambitious program to modernize its production of MOTD. This program is known as the Navy Technical Information Presentation Program (NTIPP), and is directed by NAVMAT out of the DTNSRDC. The two largest generators and users of MOTD are NAVSEA and NAVELEX, with the former having approximately 60% of the volume. The characteristics of the NAVSEA MOTD profile are given in Appendix A to this report.

Within NAVSEA, the NSDSA at the NSWSES, Port Hueneme, California, is one of the organizations having major responsibilities for the production of MOTD. In support of this work, the NSWSES operates an automated document preparation system (ADPREPS) using various Navy resources. The volume of MOTD production to be handled by the NSDSA is increasing rapidly. The ADPREPS system will be unable to satisfy future NSDSA requirements. Therefore, if the production of MOTD at the NSWSES is to continue it will have to be supported by a more capable document production system as soon as possible. Because SRI, as a previous part of this contract, had reviewed the availability, capabilities, and applicability of automated document preparation system components for the NTIPP, it was appropriate that it examine the particular requirements of the NSDSA and recommend a course of action to satisy those requirements.

The problem of MOTD within NAVSEA is enormous. Currently, there are approximately 95,000 NAVSEA TMs alone in existence. The average TM contains 203 pages and 82 illustrations. There are approximately 17 million pages and 7 million illustrations in the complete inventory.

Of this, 26 equipment codes represent over 70% of the total. The MOTD serves 470 ships in active status, each of which has a unique "suit" of MOTD essential to its operation and maintenance.

There are three areas of effort required with MOTD. First, old data need updating; second, new data need to be prepared; and third, a machine-readable data base for the entire MOTD library needs to be generated. This means that approximately 17 million pages must be captured in machine-readable form to establish the data base. Approximately 2 million of these pages each year are new material. Perhaps as much as another 400,000 pages of revised material can also be expected.

It is clear that there is a large data capture problem. For the next three to four years, the most likely method of achieving this data capture is by manual keyboarding. After that, it is likely that appropriate standards, incentives, and quality control will exist that will result in most original data capture being done in machine-readable form by contractors.

To execute its responsibilities to manage the production of MOTD, the NSDSA requires an automated production facility. The current facility (ADPREPS), at the NSWSES is inadequate, inefficient, not cost effective, and has critical components that are not under the control of the NSWSES. Current maximum throughput is limited to approximately 700 pages per month by bottlenecks in the equipment configurations. These limitations are severe, since projected volume at the NSDSA should reach 5,000 to 8,000 pages-per-month in the next two to four years. It will already be at the 2,500 pages-per-month level next year. Because of the ADPREPS limitations, no classified material can be handled by it, and 80% of the current production of all MOTD at the NSDSA is currently supported by contractor efforts.

At a throughput of 700 pages per month, the estimated cost of producing CRC with ADPREPS will be approximately $115 per page. At this same production level, a replacement system having an equivalent purchase and maintenance price of $466,000 could be substituted for ADPREPS without changing the per page cost.

Three alternatives to providing the required support to the MOTD production requirements of the NSDSA will be examined.

- Upgrading or replacing ADPREPS
- Replacing ADPREPS with contractor services
- Converting ADPREPS to a data base maintenance system.

If we assume that the NSDSA near-future production requirements will reach 5,000 pages per month, the cost of a replacement system to support this production is estimated to be $498,600, including software and system integration costs. This results in a projected cost of approximately $80 per page of finished CRC at the 5,000 pages-per-month level of production. This compares favorably with cost estimates for doing the same work at contractor facilities, although the data used for the comparison are not as accurate or comprehensive as could be desired due to the difficulty of obtaining such data from contractors.

For the future, a steady state of data base maintenance is probably the most likely evolution of the NSDSA support system. This requires careful attention to the contractual arrangements for any ADPREPS replacement system. Beyond the next three to four years, additional developments will be influenced heavily by the NTIP Program.

Based on the information gathered and analyzed to date, the following conclusions were reached.

- The ADPREPS system at the NSWSES is completely inadequate to support the NSDSA MOTD work load. In addition, it is not a cost effective system.

- There are current personnel shortages at the NSWSES that will affect the operation of any future automated document production system there.

- During the next three to four years, the NSDSA MOTD work load should expand to a rate of production equivalent to 5,000 to 8,000 finished pages of CRC per month.

- The immediate MOTD problem is the establishment of a machine-readable data base. For the next two to four years, the major method of preparing this data base will be by manual keyboarding.

- Because of the complex liaison and control problem that the NSDSA faces, there is no advantage to exclusive use of contractors to produce the required MOTD.

- Beyond the next two to four years, it is probable that sufficient standards and contractual arrangements will have been defined to make data capture in machine-readable form almost an exclusive contractor function. At that time the major task of the NSDSA support system will be data base maintenance and preparation of formatted files to produce CRC or microfiche.

- The manual methods of microfiche production for the NSDSA by the local NPPSO are in keeping with the low volume at present. After the establishment of a machine-readable data base, a device to produce microfiche masters directly from computer files will be more cost effective as high volumes are encountered.

- Due to the distance separating the NSDSA from the NSWSES automated document production system, there are unnecessary inefficiencies in the manner in which liaison and production control is handled between the two activities.

- Beyond three to four years, any additions to the ADPREPS replacement system should be defined within the NTIPP implementation.

As a result of the above conclusions, the following recommendations are made:

- Replace the ADPREPS with a facility having the capabilities described under alternative one in Chapter III. (Three alternatives are listed in Section III.B.) If the system is easily expanded, then perhaps the initial acquisition should be for ten data capture VDTs and five editing VDTs, which would slightly lower the initial cost estimated in Table III-1. Additions would then be made as volume and personnel become available.

- Alternative three should be viewed as an attractive future course of action. The NSDSA should begin immediately to develop specifications for standard formatted 9-track data tapes to be required of the various contractors. Separate contract periods for the data capture and the editing and composition systems should be considered for the replacement facility. If

alternative three is followed completely, a full page on-line formatting capability should be added to the replacement system before the APS-4 phototypesetter is released for any other use.

- As soon as possible, acquire a Branch Supervisor to manage the present ADPREPS and any new facility.

- As soon as possible, acquire a second software system person to assist and back up the present person. Use both of these persons, with NSDSA participation, to design and control an enlarged data management function for the NSDSA MOTD.

- Initiate the actions necessary to specify the requirements for the additional production personnel that will be needed to operate an expanded document producion facility.

- The possibility of bringing the present Code 5700 personnel in closer proximity to the NSDSA personnel should be seriously considered. We recognize the difficulty of making such arrangements, but its potential value is significant. If, as appears likely, the NSDSA staff is enlarged significantly in the near future, perhaps one alternative would be to assemble the NSDSA staff responsible for the production work--as opposed to the planning and STEPS file management functions--nearer to the document production facilities. Another possibility would be to prepare a new location for the installation of the ADPREPS replacement that is nearer to the NSDSA location. This would offer uninterrupted parallel operation of ADPREPS and the replacement system, as well as bringing the two major participants in the work closer together.

- With the exception of additional VDTs to handle increased volume, and the possibility of adding a full-page on-line editing capability to the replacement for ADPREPS, any additional major equipment acquisitions should be deferred until the guidelines for the NTIPP are more clearly identified. The one exception to this might be the addition of a magnetic tape-to-microfiche device, but even here the probable required date is at least two years away.

I INTRODUCTION

A. Background

This report is submitted in completion of the work performed for the David W. Taylor Naval Ship Research and Development Center (DTNSRDC) and the Naval Sea Data Support Activity (NSDSA, Code 5700 of the Naval Ship Weapons Systems Engineering Station, NSWSES) under Contract No. N00014-76-C-0407. The project entailed the compilation of data regarding the overall requirements of NAVSEA for the publication and revision of NAVSEA MOTD, and the determination of specific technology applications to the requirements of the NSDSA to carry out its MOTD publication and revision responsibilities as specified by NAVSEA for the near future. Because plans for future NAVSEA publication systems should be compatible with systems designed for future Navy-wide use under the Naval Technical Information Presentation Program, it is important from that viewpoint to review plans for near-future publication system upgrading, to be carried out at the NSWSES to support the NSDSA. Since SRI had carried out, as a previous part of this same contract, a project reviewing the state-of-the-art for applicable publication technology for the NTIPP, it was appropriate to extend our knowledge to the particular application requirements of the NSDSA, and to gather information about requirements on a NAVSEA-wide basis.

B. Objectives

The objectives of this report are to:

- Report to the NSRDC and the NSDSA the data collected and the work that SRI has accomplished.

- Provide the NSRDC and the NSDSA with an analysis of the data collected

- Present the NSRDC, NAVSEA, and NSWSES with recommendations concerning specific courses of action needed to support the MOTD publication requirements of the NSDSA in the near future.

C. Scope

This project, as described in the Statement of Work, consisted of Tasks A and B. The major part of the Task A was accomplished by the Washington, D.C. offices of SRI and is reported as Appendix A. Task B was done by the staff of SRI at Menlo Park, California, working partly on-site at the NSDSA, located at the NSWSES, Port Hueneme, California. Task A was also partially supported by technical data supplied by the NSDSA from the STEDMIS files maintained by the NSDSA.

Task A was to analyze and quantify NAVSEA requirements and current practices in the areas of data presentation, storage and retrieval, document preparation, control and dissemination, and the characteristics of document use by the various users within NAVSEA.

Task B was more specifically oriented to operations at the NSDSA and was constructed to:

- Identify the current NSDSA operations that produce MOTD.

- Identify cost and performance factors of the current NSDSA operations.

- Establish a quantitative cost-performance profile for current operations at the NSDSA.

- Identify alternative ways to accomplish the current NSDSA operations.

- Perform a tradeoff analysis of system performance investment costs and operational costs for producing the MOTD at the NSDSA.

- Extend the state-of-the-art analysis performed as the first part of this contract, if required to support the system analysis efforts for the NSDSA.

- Prepare recommendations for specific alternatives to further automate production of MOTD at the NSDSA.

D. Statement of the Problem

To maintain the readiness of the U.S. Naval Fleet of approximately 470 ships on active status requires a vast amount of technical data. These data are essential to the maintenance and operation of the ship and its equipment. They consist of various items, such as TMs, MRCs, MIPS, bulletins, lists, ORDALTS, etc. The responsilbilities for the operation, testing, and maintenance of shipboard systems are shared by NAVSEA and NAVELEX, the preponderance of the volume resting with NAVSEA.

The sheer volume of data required, including TMs, Ordnance Directives, and other documents normally classed as TMs, is enormous. On the order of 175,000 volumes of MOTD (of which approximately 100,000 are TMs), with total page counts in excess of 25 million, are required to carry out NAVSEA responsibilities. A typical ship often requires a complement of MOTD that exceeds 6,000 volumes, in addition, each ship has a unique profile of requirements. Further, the data are also used as the basis for requesting contractor bids for new ships and refitting of active ships. Therefore, the ability to associate precise individual ship identities and their MOTD profiles is extremely important.

Appendix A to this report discusses these MOTD requirements in detail and gives a view of NAVSEA overall requirements.

The NSDSA, located at the NSWSES, Port Hueneme, California, is one of a number of organizations within NAVSEA responsible for supplying MOTD for NAVSEA use. The NSWSES currently operates a limited document preparation system (ADPREPS) to support the NSDSA and other NSWSES publications responsibilities. ADPREPS, while a step forward when installed, is of limited caacity, and operates under what might be described as rather complicated conditions. Further, the NSDSA has recently had its responsibilities formally defined by NAVSEA in NAVSEAINSTS 5600.7 and 5600.8, dated 21 July 1976. Implementation of these NAVSEAINSTS will increase further the NSDSA requirements for MOTD publication. It will therefore be necessary to obtain facilities for preparing publications that are superior to those offered by ADPREPS, if NSDSA is to carry out its responsibilities. This probably means a replacement for ADPREPS as soon as practical, although the purpose of this document is to also review other possibilities. Anticipating that replacement may be necessary, NSWSES has prepared in draft form a set of specifications for a replacement. One of the items of work on this project was to review those specifications. The findings are contained in this report.

Any review of requirements for an automated document handling system for NAVSEA use should take into account the overall Navy-wide NTIP Program under NAVMAT. This program has as its goal the modernization of MOTD preparation, maintenance, and distribution across the entire Navy. This is by necessity a long-range program, which will probably not be completed for 5-8 years. It is essential, however, that document systems for introduction in the interim be planned so as to assure maximum compatibility with the long-term efforts. It is with that overall objective that SRI has conducted this project, with specific attention to the near-future requirements of NSWSES, including those of the NSDSA.

II PROJECTED PRODUCTION REQUIREMENTS

A. Overview of Requirements

1. Introduction

The scope of the activity relating to the preparation, dissemination, and maintenance of NAVSEA MOTD is difficult to bound, as seen in Appendix A. If we confine the requirements analysis to NAVSEA technical manuals, we can use some documented statistics reported, analyzed, and summarized in Appendix A. These can be used to project near term NAVSEA requirements. This is reasonable, since TMs constitute more than half of the MOTD volume as well as the bulk of the update problem.

The preparation and dissemination of TMs for which NSDSA takes direct responsibility are discussed in Appendices B and C. There are two basic methods of TM preparation currently used by NSDSA--contracting for the generation of CRC to suitable outside organizations or preparing the documents on a base-resident automated document production system under NSWSES's supervision. The dissemination of TMs is also controlled by the NSDSA through use of a computer-based distribution list.

Maintenance of these documents takes two forms, changes and revisions. These processes are also described in Appendix C. Changes represent relatively minor modification of TMs resulting from errors discovered in the documents or configuration changes. Revisions represent major revamping of the documents and are initiated when more than about 25% of a TM requires modification. They are usually effected when a new equipment baseline impacts much of the fleet or a document is

These data allow extrapolation of the size of the current problem to a dimension appropriate to the two- to three-year range that can be immediately addressed.

The problems currently requiring attention include (1) policy, (2) procedures, (3) equipment, and (4) staffing support for document procurement, review, generation or modification, and distribution. In the case of the automated document production facility at the NSWSES, the current equipment, organization, structure, and staffing levels would be largely inadequate to cope with the current TM volume throughput requirements of NSDSA. The current production facility at Code 5600 could not handle the volume of deficient, new, and changed manuals under the cognizance of the NSDSA, even if the text were already stored in an automated data base. Technology upgrade and system streamlining can improve the throughput to make it match more closely the high APS-4 phototypesetter capacity, but doing this would also entail augmenting the staff to support higher volume processing. This staff spans composition and editorial staff, data capture personnel, text processing supervisors, document managers, coordinators, quality review staff, standards engineers, system specialists, program monitors, and others. These functions as they apply to TM maintenance are currently performed at NSWSES by Codes 5600 and 5700.

2. Change/Revision Characteristics and Procedures

In the course of upgrading the current TM status, a backlog of deficient TMs was identified; current operations have not coped with this developing backlog. Furthermore, since much of the work is contracted out, there is insufficient control over quality, and standards are frequently not followed. Moreover, each revision cycle for a TM is equivalent to a new document procurement, and will be until an automated data base is developed. A revision presents a problem that requires immediate attention. However, changes are, in general, confined to limited modification of content and presentation format, and do

not offer the opportunity for reorganization, significant restructuring, or other major document quality improvement steps. The latter upgrading approaches are invoked as required at revision time.

The Shipboard Microfiche Test (SMT) program has introduced a need to reorganize the MOTD. Chosen test documents have required major formatting to map them into a form conveniently usable in the fleet in the microfiche medium. Reorganization has been required even though the set of test documents selected were deemed particularly suitable for the microfiche medium.

We will examine the merits of an automated production support facility for use in generating documents that are expected to undergo user revision and change periods over a long life--on the average five to seven years between changes and seven to ten years between revisions. With such a facility, the captured data base can be repeatedly mapped into a modified, reorganized, or reduced data base, with a core of textual material that remains basically the same in content. However, if more than 50% of the document must be replaced, then the value of the captured data base is greatly reduced--that is, it may cost less to generate a new document than attempt to edit and recompose it.

3. TM Volume Statistics

In view of the above, it is important to consider carefully the change characteristics of TMs. In particular we will consider the potential value of a captured data base in an automated system.

In the analysis in Appendix A, the necessary statistics on TM change histories are reported. Normal changes to reflect modifications or to rectify errors are processed with an average historical frequency of 2.5 pages per TM per year, leading to a total of 240,000 pages per year out of 23 million 8.5-by-11 inch pages of TMs. The number of manuals that are classified as deficient each year varies between 300

and 1,000. Several years of accumulated deficient documents are now backlogged, representing between 5,000 and 16,000 pages, and the number is increasing. Thus, if they could be corrected at the same rate that they are identified, the steady state level would be at 100 to 300 volumes per year. These documents essentially need to be generated anew, although if there were a captured data base, some portion of that data base would perhaps be reused. Furthermore, the reasons for these deficiencies are varied, in some instances resulting from a lack of control over the standards. In other instances, deficiencies are caused by the procurement of documents from equipment vendors that are mostly promotional in content, with insufficient coverage of maintenance and operation.

These problems may be reduced with a Navy-wide automated system as currently under consideration in the NTIP program, especially after standards are normalized and control is strengthened. Such manuals will then rarely get into the deficiency library. Thus, eventually, the deficient manual category could be significantly reduced to basic configuration changes. However, we will consider deficient manual statistics as reported currently in the TMSR to address the near-term problem. These statistics, considered in light of the events stated in Appendix A, will be used below to project TM modification requirements.

We should use caution in interpreting these statistics, since the 2.5 change pages per year are clearly not representative of the volume of changes that are imposed each year but rather the average over the TM's lifetime.

4. Static Files

If, as indicated, the motivation for most changes is error detection and correction or configuration change, then the frequency with which changes are applied is tied to the occurrence of such events.

The average number of years between changes is on the order of seven years, based on the sample of documents surveyed in the TMSR. Thus, an average of five or six years between changes, together with the probability for a change requirement existing, lead to approximately 0.3% of the documents requiring modification each year.

B. Data Base Management Alternatives

1. Document Selection

To obtain the maximum benefit from initial use of an automated system, it is important to select documents with the highest change history, but which undergo infrequent revisions. In this way, the captured data base can be utilized to full benefit to support a task that otherwise might be quite burdensome. For example, if a typical TM lifetime were seven to ten years, then a change every three to five years would be sufficient to make that document worth selecting. Conversely, to start with, it would be wise to leave the volumes that are relatively static in a manual form and to focus on the changing TMs for "capture"--i.e., entry into the system. A convenient time to initiate capture and automation would be when the documents come up for revision, and thus must be regenerated.

In the case of revisions, the captured data base will also prove to be of value. Sections that have not been rewritten can be carried over, thus obviating the need for recapture and editing. Reorganization can be effected in a straightforward manner using an automated system, provided significant rewriting is not also indicated. If more than about 30% of the document is modified, it may be more efficient to recapture the material. Deletions of material not pertinent to the document's purpose can be easily carried out with a captured data base. Additions are also readily handled in this manner.

The above comments do not apply to data that are stored only on paper. When CRC in the form of paper needs change or revision, any modification over and above minor typing corrections requires retyping the document. If the document was produced by an outside contractor and the type font is different, the document will need to be retyped, or else returned to the contractor for revision. Thus, the value of paper storage of TMs is minimal from a change or revision viewpoint.

2. Document Storage

Document storage presents various considerations. The several types of storage have varied characteristics. The master storage methods of importance here include archive storage of the paper-based CRC, microform storage, or computer-readable data base storage. Document storage circumstances include shipboard storage of documents pertaining to the maintenance and operation of on-board equipment, library storage of MOTD documentation, and overhaul center document storage where corrective maintenance and modification of equipment takes place. Since each of these classes of usage implies different considerations, modes of use, and frequency of access, it is important to consider each category.

a. Archive Storage

Master document archives are infrequently accessed, and then primarily for change or revision. Thus, the storage medium should allow for compact filing but provide relative ease of reference and access on an infrequent basis. Ease of modification of the retrieved data is then highly desirable. Computer archiving is currently done on magnetic tape and less frequently on removable disk packs. Tape is a highly compact form of storage. One reel of 800 bpi tape can store approximately two million characters of text, or approximately 4,000 average document pages. A tape library with a well organized indexing method provides ease of document reference and access. Documents can

then be flexibly manipulated under computer control. This storage method is suitable only for use at the document production and control facility, because of the skills required for accessing and modifying the data and because the data consist currently of only text with the illustrations stored separately. It should be noted that the text should be stored in an automated system without embedded composition commands to enable readily using the captured data base for change or revision.

b. Shipboard Storage

Independent of the method of document production, the documents that get disseminated to the fleet can be in one of two forms, currently microforms (predominately microfiche) and paper copy. Microfiche is coming into more widespread use, since work packages are being formed for preventive shipboard maintenance, and most of the TMs required by a ship then need to be stored and retrieved only infrequently--as when an abnormal problem surfaces. In general, corrective maintenance is postponed until shore overhaul, if possible.

Microform storage, particularly in the form of microfiche, is a very compact form for shipboard storage. It may be readily maintained in a small space in an organized manner such that access is quick and efficient. Paper copy takes up large amounts of storage, degrades more readily, and in view of the volume of material required on shipboard (typically 2,000 to 3,000 TMs and significant additional MOTD), presents large storage space problems. Computer access of digitized manuals on board ship is not a technologically viable alternative at this time. However, eight or ten years into the future, such an approach may be feasible and even economically practical. Videotape or videodisc storage methods likewise may become practical approaches in the future, but are not practical today.

c. Library/Overhaul and TM Storage

Shore libraries maintain ship TMs for a number of purposes. Often libraries are located near overhaul centers for the maintenance of technical data pertinent to ship overhaul. These centers perform the bulk of the corrective maintenance and engineering modifications on shipboard equipment during a ship overhaul. TM libraries are also located at a number of ISEA sites responsible for MOTD maintenance. There are approximately 100 libraries that maintain comprehensive catalogs of TMs and other MOTD. Access to these data is in support of engineering and maintenance activities. Storage here is not a problem, and documents generally are needed in paper copy form for use in shops and service centers. While microfiche could be used, random access to the requested data in an efficient manner may not be practical. Procedures would need to be rationalized to determine the effectiveness of microfiche in this environment. Many TMs, however, may be infrequently accessed and would not be suitable for shop use. These may then be retained in microfiche form.

3. Document Usage

a. Update/Revision Requirements

We have already considered the factors facilitating update and revision and have seen that a computer based document system is the most practical approach from the standpoint of access, editing, composition, and CRC generation for either paper or microfiche. Both microfiche and paper forms of storage require manual replacement of sections in question. Illustration modification currently must be done manually, but text that is stored on a computer is much faster to access, to edit, and to output with standard production tools than is manual regeneration. The type of production tool referred to here is described in detail in the next chapter (III.C.4). Independent of the

form of the delivered document, computer based document editing and composition today is more efficient and adaptable to Navy requirements than manual production methods.

b. Shipboard Use

We saw previsouly that the current operation mode on board ship focuses primarily on preventive maintenance for which MRCs and Maintenance Work Packages provide the necessary MOTD. Thus TMs are available for emergencies, but are infrequently accessed. Previous sections dealt with different media for storing TMs on ships and concluded that only paper and microfiche formats were realistic in the next two to three years. Of these, paper consumes an excessive amount of room for the very confined space of a ship or submarine. Hence microfiche offers distinct advantages from a storage viewpoint. However the use of microfiche, particularly in an emergency situation, can be much more awkward than the use of paper. Location of the desired microfiche can be efficient if the microfiche library is carefully organized. However, use of the data in a microfiche form requires a microfiche reader that, in most cases, must be portable. Thus awkward or tight places in or about equipment requiring maintenance may not offer adequate room for a portable reader. Documents must be organized for efficient access in the microfiche medium. For instance, a figure must be located next to its references in the text for ready access. Human engineering aspects of portable microfiche readers include not only reliability and ease of manipulation of microfiche, but also ease of reading under poor lighting conditions, economical styling to allow fit into tight spaces, light weight for easy manipulation, and rechargeable battery operation for situations where no electrical outlets are available. Several models are being tested for use now, but may not come into widespread use for some time.

A preferable method of microfilm use in many cases would be to have a copier on board that produces paper copies of individual microfiche frames. Appropriate pages could then be selected on a microfiche reader and hard copy generated of those pages required for the necessary work. Since this approach requires minimum changes in the method of operation and is suitable for widespread use, it is an approach that could come into common use in the next few years.

On-line access to computer stored files for maintenance uses is unlikely to become a viable alternative in the next five years. It would require a major amount of equipment, would need to be designed with high reliability, and would depend on satellite transmission of data until compact direct access storage for digitized drawings and illustrations is available. The merits for this approach, even if technology could accomodate it, are viewed with skepticism since the man-machine interface for information retieval would need careful design and, in all likelihood, highly specialized skills. This approach will be untenable for a number of years.

c. Library and Overhaul Use

There has been a growing trend in the direction of computer access of bibliographic and abstract data bases in libaries in recent years. Library and information systems specialists have become increasingly visible in libraries, as have data base access terminals and related equipment. Such systems are generally useful for searching data bases for specific content, key words, or data fields for matches. They are generally bibliographic and not document-oriented. Since libraries that are used in part by overhaul centers and activities having engineering responsibility for equipment, it is not clear that computer-searching mechanisms for whole documents would be of value. In addition, large scale computer based storage is not advanced enough yet

to handle such a large amount of data on a cost effective basis. It will take several years before technology could support such an approach.

These libraries have increasingly moved toward microfiche form for some classes of documents. This makes good sense for documents that are used for review or reference purposes. However, maintenance and overhaul centers will continue to require hard copy for use in servicing equipment.

4. Documenent Dissemination

TMs are broadly distributed in the Navy. Recipients include all activities with a given piece or type of equipment, libraries, and overhaul centers worldwide, plus ships in the fleet with the equipment. Currently distribution is in the form of hard copy and/or microfiche. There are currently several distribution centers in NAVSEA of which the NSDSA is one. At Port Hueneme, a data base is maintained containing Navy wide activities and their addresses. Separate distribution lists are maintained for specific manuals. The data base undergoes continuous revision as activity responsibilities, equipment profiles, or ship configurations change or addresses need updating. A description of the distibution process in effect at the NSDSA is given in Appendix C.

Currently, paper copies are distributed when the document is produced, but microfiche generation and distribution are queued for periodic processing. As microfiche comes into wider use, output in this form will be tied more closely to the production process and may in some instances be the only form of output. The microfiche will then be distributed in much the same way as paper copy is now handled. It is clear that this form of output will have to be more directly supported in the future and the volume output will be significantly heavier. If the fleet converts largely to microfiche use, NPPSO will have to expand its operation to accomodate the increased volume processed at CBC.

C. Summary of the NSDSA Requirements

The NSDSA currently assumes direct support for 17,000 pages per year of TM production, which is expected to grow to 30,000 next year. The recent NAVSEA Instructions 5600.7 and 5600.8 define an enlarged program and more rigid policy for the acquisition and management of technical manuals procured from the commercial sector. As a result, the NSDSA must take a more active role in assuming and effecting tight control on TM standards and ensuring consistent support of TM maintenance. Consequently, the degree of TM management that the NSDSA actively assumes is expanding, and an effort to standardize procedures and improve control over TM generation is underway. Several programs are being aggressively pursued. The NSDSA is developing the STEPS data base to maintain records on the status of TMs in a consistent and useful format for effective manual management. It is also assuming responsibility for the production part of the SMT program. This includes selecting appropriate TMs, reformatting the selected documents, having the NPPSO generate the master microfiche and generate the copies needed for distribution, and then performing the distribution. The NSDSA is also managing the distribution of selected ordnance TMs and is expanding the classes of document distributions being handled. The NSDSA expects eventually to assume direct responsibility for all NAVSEA TM distribution.

The NSDSA is also directing the improvement of the TM production cycle. It is moving toward tighter control of the process by doing the work in-house on an automated facility. This expanded base support requires significant upgrading of the Code 5600 automated document production facility, as described in Chapter III. Limitations of this facility are described in Appendices C and D. Thus many of the considerations in this report are of immediate relevance, namely upgrading the current facility and acquiring a capability in line with the future Navy-wide NTIP MOTD production program currently in the early phases.

The current level of 17,000 pages per year of documents represents only about 6% of the outstanding deficient TMs. There are about 950 documents currently in the Deficiency File and the number is growing. If we assume that the end objective of the NSDSA is to handle all of the deficient TM's, the current annual requirement could be on the order of 250,000 pages per year. That volume of throughput will not be achieved in the next three to five years, but a system is required which can be upgraded to that potential level. These requirements are addressed in the next chapter.

III IMPLEMENTATION ALTERNATIVES

A. Introduction

In this chapter we shall examine some of the alternatives that might be employed by NSWSES to improve the support of the NSDSA publication of MOTD. Before that is addressed, it would be well to restate some of the background conditions, briefly describe previous supporting work, and examine the probable schedules for implementating such an improvement program.

1. Background

As stated in the SRI Statement of Work for this project, the work of Task B was to be "...specifically oriented toward the NSDSA work at Port Hueneme, California ...set within both the context of NAVSEA overall requirements and participation of NAVSEA in the NTMS program ... and ...restricted to that set of equipments necessary to provide a FY 77/78 automated production and update capability for MRCs and TMs."

When project work began, several things occurred. First, it was found that the NSDSA publication support facility (ADPREPS) was operated by the NSWSES at Port Hueneme, and that the system was then being reviewed by the NSWSES for upgrading and/or replacement. Therefore, one area of involvement not anticipated was the provision by SRI of review and comments concerning the technical contents of the specifications for upgrading the existing system. Next, the NTMS program became the NTIP program. Finally, although FY 77/78 was the original target date for the desired implementation completion, it was soon apparent that this

discussed below, in the Navy environment. With just the major tasks shown, the following would be a typical representative schedule.

Requirements definition	3 months
Performance specifications	6 months
Personnel authorization and acquisition	1 year
Specification review and approval	3 months
Vendor bid preparation	2 months
Bid evaluation and contract issuance	3 months
System implementation	6 months
System installation and acceptance	2 months
Parallel operation	3 months

Of the above steps, only personnel acquisition can proceed in parallel with other steps. Therefore, we see a typical beginning-to-end cycle of 28 months, assuming that the financial program elements have been correctly established before the requests for bids are ready for issuance.

Based on the above typical time requirements, should the NSWSES start from scratch today, we would not expect any resulting system to be in full operation until almost two and one-half years from the issuance of this report. This would be well into FY 79 and is the main reason why the time frame of this project was extended from the original FY 77/78 reference.

Some further observations can be made. With regard to the NSWSES itself, the upgrading or replacement of ADPREPS is not now at time zero, but rather is approximately nine months into the schedule of events. Therefore, if the procurement is executed, we would expect that any resulting new system would be in full production about the end of FY 78. However, a year or more of operational experience will be needed before any additional system requirements can be accurately described. Again, estimating that the follow-up process will take at least an additional

18 months, this would bring any such further development well within the time frame of the NTIPP implementation. The conclusion that seems clear is that whatever course NSWSES follows for the next one and a half to two and a half years will establish NSWSES document production support capabilities until the NTIP Program is in its implementation phases. For that reason, more than usual attention will be necessary to ensure system adaptability during its lifetime.

C. Design Considerations

Chapter II and Appendix A of this report describe in detail the magnitude of the problem facing NAVSEA and the NSDSA. The important point to note is that, for the immediate future, the establishment of a machine-readable data base will be the primary concern of the MOTD publication support system. As the data base is established, the shift will slowly be away from this phase until it becomes secondary to maintenance of the data base (MOTD updating). Therefore we believe that any automated document publication system for the NSDSA should *concentrate on the establishment of a machine*-readable data base for the next three to four years, or for the time period under consideration in this report. This is a key design consideration, since other performance requirements are heavily influenced by this factor.

Next, for reasons described in detail in the previously referenced report for the first part of this contract, we believe that manual keyboarding will be the predominant data capture method used during the next three to four years. Again, this will change in the future to other methods such as OCR and formatted tapes, but the present lack of standards, quality control, and financial incentives indicates that keyboarding will remain dominant for the time period considered by this report.

Further, and we recognize that there is some professional disagreement to be expected on this point, we do not believe that paper

will be eliminated from document preparation systems within the foreseeable future. Certainly, microfilm and microfiche are rapidly becoming widespread as document reproduction media, and others such as video disks show promise. However, there is a large difference between reading a finished document and editing, composing, and updating that same document. Until an integrated document production for the entire NAVSEA can be implemented (probably within the NTIPP), in which all parties concerned can examine a document in the preparatory stages, on devices such as VDTs driven from a common data base, there will continue to be a flow of paper until the final approved version is completed. We do not believe the situation will be changed significantly within the next three to four years, although such changes must continue to be an important factor in the planning of any such systems.

With the above major considerations in mind, it appears that there are three major alternative methods of supporting the NSDSA publication of MOTD that should be considered. These alternatives are:

(1) *Upgrade ADPREPS or replace it with a new system*
(2) Replace ADPREPS with contractors' services
(3) Convert ADPREPS (or its replacement) to a data base maintenance system.

D. Upgrading or Replacing ADPREPS

In order to properly examine the value of upgrading or replacing ADPREPS, its limitations should be understood and, most important, its costs projected to future work volumes. Once this is done, the question of equivalent replacement system costs can be addressed. Finally, a representative system with actual estimated costs can be described.

Table D-1 in Appendix D gives a summary of the major current ADPREPS costs. Based on this information, two analyses will be performed: (1) one dealing with those costs that contribute to the

current rather high per-page costs, and also dealing with volumes of the same relative sizes as at present, and (2) a second dealing with the question of increased volumes most likely to occur in the future.

Whenever costs or cost savings are spoken of in the discussions that follow, it is with the realization that this represents a savings to the Navy as a whole, a savings that may not all accrue to the NSDSA due to the way in which the budgets are derived and administered.

1. Current Production Volume

For the period represented by Table D-1, an average monthly production volume of approximately 135 pages was maintained. Records up through July 1976 were also examined and it was noted that an average of 275 pages per month was achieved for the last five months of that period, with one peak of 596 pages reached in June. Although the volume in June was high, it is impossible to determine whether that figure represented mostly work of the APS-4 which, as will be discussed further later, is capable of handling many times that volume, or represented the normal complete cycle distribution of work. At any rate, experience by ADPREPS management has led them to conclude that during any one day, a maximum of approximately 30 pages of complete work can currently be processed through the system. This limitation is imposed by the configuration of the system and the bottlenecks represented by the data handling paths. It is interesting to note, disregarding the capacity of the APS-4, that the proper amount of data entry and editing stations appear to be present to support this volume. Therefore, it would be realistic to put an upper limit of 700 pages per month, on the average, as representing the upper production volume of ADPREPS. Based upon this limit, we can derive the following from Table D-1.

Variable costs/page = $54,930/533 pages
= $103.06/page.

Fixed costs/page = $34,920/(4 x 700 pages)
= $12.47/page.

Total Cost = $115.53/page .

This can be compared with the figure of $168.57 per page average for the four-month period examined. The obvious point is that, given that the volume requirement is there, and there is ample evidence that it is, the staff of ADPREPS in the data entry-format editing functions should be increased to bring the system throughput to close to the limit. It is quite likely that the figure of $115.53/page can never be realized because the fixed costs will probably not stay completely fixed. We do believe, however, that a figure of $135.00/page is realistic, and this represents a 20% reduction in the cost per page as experienced during the sample period.

2. Equivalent ADPREPS Costs

Further extrapolations can be made from Table D-1. First, the costs directly connected with operating through FLTAC can be updated and represented in terms of facilities that could be added to or could replace part of ADPREPS, without increasing the present per-page cost. Again, based upon the upper limit of 700 pages per month, the following figures from Table D-1 can be derived, where C = the data preparation costs plus the FLTAC computer costs:

C = $5,690/4 months
= $1,422/month

Communication Costs = $((\$1,000)\ (700\ \text{pages/month}))/533\ \text{pages}$

$= \$1,313/\text{month}$

Total $= \$2,735/\text{month}.$

This figure can be translated into terms of additional facilities by assuming a monthly maintenance of 10% of the equivalent monthly lease cost and assuming a typical 40-month amortization for the facilities. The resulting figure is:

$$(\$2,735 \times 40/1.10) = \$99,455.$$

This represents approximately $100,000 of additional or replacement facilities that could be obtained from cost savings that are known. In addition, there are costs that can be identified relating to the operational methods themselves, that, while not as firm as the operational costs, can be determined with a reasonable degree of confidence.

The ADPREPS management has kept detailed logs of the system downtime in order to be able to predict system throughput more accurately in the future. For example, during the month of June 1976, causes directly relating to either Code 0300 equipment or FLTAC equipment malfunctions resulted in a loss of production time conservatively estimated (the benefit of the doubt went to the equipment when questions arose about the losses) at 94 person-hours. During that same period, a total of 1,153 person-hours was expended during the regular day shift when the troubles occurred. The loss of time is equivalent to approximately 8% of the total time used. June was not an isolated month; the figures for May show approximately 75 person-hours lost in the same manner. Further, these figures relate to the average production throughputs of approximately 250 pages per month, and a higher rate of 700 pages per month would show an increase in this percentage, since more production would be halted by an interruption.

Next, consider the methods of data editing caused by the communication with FLTAC. It is our considered professional opinion that at a minimum the data entry and editing efficiency could be improved 20% by the use of a state-of-the-art editing system that allows choices to be made between editing for format and editing for content, that provides one-for-one correspondence between hard copy reference proofs and VDT formats, that provides local on-line file management and control, and that allows communication between terminals and computer at the full 9600-baud rate typical of present systems. We believe this to be a conservative figure that does not even consider error rates, undetected delays, and complete schedule slippages present in the current methods. This figure, while not as directly tangible as the downtime figure previously described, is nevertheless real and can be considered with confidence.

Considering the two figures above and conservatively summing them to a 25% figure, referring again to Table D-1, projecting the publication rates to 700 pages per month, and using the variable cost for data handling given in Item 3., Table D-1, the following is derived:

($20,860 x 700 pages/month x 0.25)/533 pages = $6,850/month.

This represents a savings in future operations costs. Again, translating this to terms of additional facilities, in the same manner as for the downtime figures, the following is obtained:

($6,850 x 40/1.10) = $249,090,

or approximately $249,000 worth of additional or replacement system facilities.

Summing both figures gives a total of approximately \$349,000. This figure represents the worth of equipment and/or software that could be added to the present system without affecting the per page cost of the system, based on the estimated maximum throughput of the current system of 700 pages per month.

The final step is to add to the above figures the equivalent cost of replacing the current data-entry/data-editing equipment with different equipment. This is done again referring to Table D-1, Item 5, and using the figure given there for the costs of this equipment. Doing that, one derives:

$$(\$8,230 \times 40 \text{ months})/(4 \text{ months} \times 1.10) = \$74,818,$$

or approximately \$75,000. The total then becomes \$424,000. This represents the amount that could be spent over a 40-month period to replace the current ADPREPS (hardware plus sofware, but excluding the APS-4). Maintenance of the new system is provided for in the savings and would be an additional \$42,400 over the 40-month period. This amounts to a total monthly expenditure of \$11,665. It would result in the cost to NSDSA of approximately \$113 per page, assuming the throughput of 700 pages per month is not exceeded.

This cost was derived as follows:

$$\underbrace{(\$11,665 + \$6,400 + \$6,760)/700 \text{ pages}}_{\text{Fixed}} + \underbrace{\$77.91/\text{page}}_{\text{Variable}} = \$113.37/\text{page}.$$

The variable costs of Table D-1 have been adjusted to reflect a 20% increase in productivity (Item 3) and the replacement of Items 5 and 8 by the new system components.

If the throughput of 700 pages per month is exceeded, the per-page costs would be lower. As we shall see later, it is far more likely that, for the costs shown, a replacement system could handle on the order of 5,000 to 8,000 pages per month.

3. Projected Near-Future Production Volumes and Costs

As with any projection, the farther one predicts into the future, the more the projections are error prone. However, for purposes of this report, since we are limiting the period to no more than four years from the present, some rather firm projections can be made. First, for the immediate future, next year, we already know that the current NSDSA page counts are at 17,000 per year and will most likely exceed 30,000 per year, or 2,500 per month, by the end of next year. It can immediately be seen from these figures that the current ADPREPS is completely incapable of handling this work load if it is all brought within NSWSES, as is desired by the NSDSA. At most, it would handle 1/3 of this load, assuming the complete cycle is handled. Based on projected NSDSA budgets, the volume should reach 60,000 pages per year, or 5,000 pages per month by FY 80.

In addition to the current well defined work load, NAVSEA Instructions 5600 and 5600.8 (dated 21 July 1976 and dealing with the acquisition and maintenance, respectively, of NAVSEA MOTD) have greatly enlarged the scope of the defined responsibilities of NSDSA. Paragraphs 7.b.(1) through (30) (Responsibilities) of NAVSEAINST 5600.7, and paragraphs 6.b.(1) through (32) (Responsibilities) of NAVSEAINST 5600.8 in particular spell out in some detail these responsibilities. A great deal of emphasis (paragraphs (2), (3), (7), (9), (11), (12), (13), (17), (19), and (24) of NAVSEAINST 5600.7) is placed on an integrated approach to MOTD acquisition, preparation, publication, distribution, and control and the development of implementation procedures for getting MOTD into machine-readable and microfiche form. It is impossible at this time to determine what additional MOTD publication responsibilities this will

entail; however, referring to Appendix A, one can see that should NSDSA become actively engaged in the production of only 1% of the NAVSEA MOTD, that would represent over 250,000 pages annually. Assuming that the experience of the change history of NAVSEA MOTD as presented in Appendix A is reasonably accurate, then an estimated additional 60,000 to 100,000 pages per year can be expected to be handled by NSDSA.

Since the development of the program spelled out in the two NAVSEAINSTs will require a long time to completely implement, it is our estimate that during the next three to four years an upper bound of 100,000 to 150,000 pages per year (8,500 to 12,500 pages per month) of MOTD will be handled by NSDSA itself, together with its responsibilities to manage and control the remainder of the NAVSEA MOTD acquisition and maintenance program.

What can be extrapolated from the upper limit of these figures? First, it appears that the APS-4 can support this amount of production almost within a single eight-hour shift, and rather easily if two shifts are considered. Under production conditions, for the formats encountered in the MOTD today, the APS-4 can produce 2,400 pages per eight-hour shift. If normal production statistics hold, approximately two working copies for editing will be produced for each finished page of CRC. This means that the effective maximum throughput of the APS-4 system is approximately 800 pages of CRC per eight-hour shift. If an average work month is considered to be 20 days, then we can expect the APS-4 to easily be able to produce monthly 10,000 final CRC pages on a single eight-hour shift per day basis. This level of production will not be reached, in our opinion, for at least four years; so, until that time, the APS-4 should be sufficient for the NSDSA CRC requirements and should require only a single shift of operations to do so.

Next, a final set of projected cost figures, based on current costs, can be made for the above production rates. We assume (1) that all of the current equipment is replaced by a stand-alone system, having

an equivalent cost as described under C.2 above, (2) that the variable costs (minus the FLTAC costs already accounted for) are projected on a per-page basis at the rate shown in Table D-1 (adjusted for a 20% increase in productivity for Item 3), and (3) that the entire monthly lease-maintenance costs of the APS-4 ($6,760) are assigned against this production; under these conditions the cost is equal to:

Fixed	Variable	
($11,665 + $6,400 + $6,760)/10,000 pages	+ $93.35/page	= $195.83/page.

This estimate is very conservative since it only includes a 20% increase in productivity as a result of using a more efficient and more reliable system, it does not include any reduction in liaison costs achieved through system integration, it projects the costs for additional data entry and editing equipment needed at the current rate (which is high), it assumes that the APS-4 is not producing any other revenue, and it assumes that $466,000 will only replace the current system, not augment the capabilities as well.

One significant fact can be noted from the above. At these production rates, the fixed costs represent less than 3% of the total cost. This example has considered only the generation of completely new CRC. For MOTD update, the fixed costs percentage would be greater. However, the total per-page cost would be less since there would be much less keyboarding and proofing required.

4. ADPREPS Replacement

a. Operational Considerations

In the preceeding discussions we examined the approximate cost that could be equated to achieving roughly the same type of capability as that provided by ADPREPS today, taking into account

increased volumes and moderately increased efficiencies. Now we shall look at a specific set of technical requirements, and define the general technical parameters and equipment needed to provide the required capabilities. In order to do so properly, the operational objectives of the system must be defined; five of these objectives are stated in broad terms below.

1) Separation of the Data Capture System from the Data Editing and Composition System

As was stated previously, it is our considered opinion that data capture from keyboards having limited VDT capabilities will be the predominant method of data capture for the immediate future. We believe that it is essential to proper system utilization that the data capture function be separate from the other functions, since only in this manner can malfunctions or development of the editing and composition systems be isolated from the data capture effort, and vice versa. The preponderance of production personnel will be in the data capture area, and this effort will be the one that most influences timely production, assuming all system components function properly. Therefore, it is important that this effort not be interrupted by difficulties in other system components. Further, with time the data capture function will wax and wane. At system initiation, a smaller capability will be required than when a full production capability has been developed and the proper staffing has occurred. When the data base maintenance phase is reached, the function will once more be reduced in size. Ultimately the function may be required only for exceptional situations, such as when a vendor cannot deliver formatted tapes, OCR copy, disks, or similar media on which the raw data will be stored in machine-readable form. It is important, therefore, that the data capture system also be modular so that it can both grow and shrink as long term production requirements change.

2) Separation of the Editing and Composition Functions Within Their System

We believe that this can best be accomplished through the provision of separate on-line data storage facilities for those files associated with current data in-process and data that are in a form suitable for production of CRC. The object of this approach is perhaps obvious; elimination of accidental destruction or alteration of data files that are in final form. Separation of the two functions by the use of separate physical storage devices will decrease the likelihood of such accidents, though it will not completely eliminate the problem.

3) Operation of the APS-4 as an Off-line Device

Continued operation of the APS-4 off-line from the editing and composition system is assumed. This allows maximum flexibility in scheduling the use of the APS-4, provides for accommodating inputs from sources other than the NSDSA, minimizes the downtime of either system caused by the other, and minimizes the requirements for computer resources.

4) Initial System Throughput not to Exceed 5,000 Pages of New Material Per Month

We believe 5,000 pages per month of new material to be a realistic figure for initial system throughput (the first two years). This is based on known projections of the NSDSA workloads. However, the authorization, acquisition, and training of the required personnel to provide the data capture, editing, and formatting functions is even more restricting. The throughput will eventually exceed even the 10,000 pages per month capability of the APS-4 for a single shift operation, but for the immediate future we believe that a ten-fold increase in the present production is a more reasonable estimate.

Data Capture -- The data capture computer can be one of a number of commercial minicomputers currently available. For a 16 VDT terminal system, the central processor unit (CPU) should have at least 32,000 eight-bit bytes of main memory. The CPU should be byte oriented, and the Operating System (OS) software should generate disk files from the VDT inputs that are compatible with the files used by the OS of the editing and formatting system CPU. Since all 16 VDT input terminals may not be located near the data capture system CPU, it should be capable of correctly interfacing with communication lines through modems having standard EIA/CCITT characteristics, at speeds up to 9600 Baud, for future requirements. For the data capture function, fast internal memory cycle times are not required; nevertheless, state of the art cycle times of one microsecond should be easily obtained.

Data Editing and Composition -- Again, there are a number of commercially available minicomputers today that can satisy the CPU requirements for this application. Preferably, it should be of the same manufacturer's line as that of the data capture CPU. It should be byte oriented and have at least 128,000 eight-bit bytes of main memory. Since composition will be a demanding task of this machine, main memory cycle times of less than one microsecond should be required. This CPU should be capable of future interfacing with a number of devices (such as OCR readers, floppy disks, and video disks) through general purpose interface devices. It should also provide communication line ports for devices having standard EIA/CCITT electrical characteristics, operating at speeds up to 9600 Baud. Some expansion capabilities in the form of extra cabinet space, power supply capacity, and hardware mounting locations should be obtained with the original configuration, to eliminate unnecessary reconfiguration and ensuing down time in the future.

The software for this system can be one of a number of general purpose text handling systems built for minicomputers. (An example of such a system is the UNIX software of the Western Electric Company.) These software packages can be made to correctly format data for acceptance by a number of printing or photocomposition devices through the use of modular software that describes the device characteristics. The software should have intrinsic OS and file handling capabilities as a part of the text handling package, rather than having a separate unique OS.

The software should be supported by the existence of a regular support staff available from the vendor. Training programs should also be available from the vendor. If a standard package is not used, then the development cost for the system software will probably be five to ten times that of a standard vendor's package.

2) VDT Considerations

Data Capture -- If we consider an upper bound of 5,000 pages per month in terms of keyboarding and editing, then this can be translated into terms of input and editing terminals and storage requirements to support the APS-4 production. Assuming that each input station can produce approximately three pages (15,000 keystrokes per hour) for six productive hours per shift, we obtain a figure of 18 pages per terminal per shift. To support a monthly throughput of 5,000 pages, approximately 16 input stations (on a single shift basis, allowing for spares) will have to be provided. Should two shift operation be implemented, then of course the number would be halved. The VDT terminals used for this function require only minimal display capacity. However, they should provide a full standard ASCII character set from a typewriter-like keyboard, with provision of some function keys to simplify the entry of formatting instructions.

Data Editing and Composition -- In terms of editing, it is our experience that correction and format editing, using a well designed text handling system, proceeds at a rate at least twice that of the throughput of raw data entry. Thus we expect that no more than seven editing terminals, on a single shift basis, will be needed to support the APS-4 throughput. These terminals should have a full standard ASCII character set and the ability to display at least one half page of formatted material (2,500 characters). These VDTs should have a typewriter-like keyboard, a controllable cursor, formatting function keys, selectable image intensification, scrolling, and perhaps reverse video. To relieve the associated computer of much of the routine display processing tasks, these displays should each have enough local memory to accommodate temporary storage of two to three pages of textual material. For the immediate future, there will be no requirement for a vector drawing capability; however, displays having such capabilities will become useful when simple line drawings are digitized and added to the data base.

Both types of VDTs described above should be capable of operating at different selectable data rates, ranging from 30 characters per second to 1,000 characters per second (300 to 9600 Baud). They should have a full EIA/CCITT electrical interface, with internal electronics to allow data transmission and reception from remote locations via communication devices.

c. Random access storage considerations

(1) Data Capture

For data capture, storage for the production of one day of data entry must be provided, if frequent interruption of the entry process is to be avoided. One shift's worth of data entry represents approximately 250 pages of 5,000 characters each, or 1,250,000 characters of storage, at a minimum. A state of the art

cartridge disk system would easily satisfy these requirements. The disks themselves would be easily transportable from the data capture system to the editing and composition system and would provide a very efficient and rapid method of transferring data between the two systems.

(2) Data Editing and Composition

In terms of working storage for editing purposes, a two-week period (or ten working days) of on-line storage of text must be provided. This is the minimum requirement -- one month's storage is preferred. For that amount of text, at least four versions should be maintained, representing various working copies of the text. Finally, because the text will now have its necessary complement of APS-4 composition commands embedded, the volume will be 20% above that of a page of raw text. Considering all of these items, a minimum on-line random access storage capacity of 60 million characters will be needed to support the APS-4 throughput. If this capacity is to be equally available for either the editing or the composition functions then a minimum of two storage units each having the above capacity will be required. A third unit will be required to allow archiving, copying, and to provide backup.

Magnetic Tape -- The editing and composition system will require the use of standard industry compatible 9-track magnetic tapes for archiving of the finished document files, file protection for current work, and to provide input for the APS-4. Because of the size of the disk files, in excess of 40 million characters, the tape transports should be capable of producing and reading magnetic tapes with a recording density of 1600 bits per inch. The transports should accept reels with twenty-four hundred feet of tape and should have a standard operating tape speed of at least 45 inches per second. Three tape transports will be needed to provide both a background tape-to-tape and disk-to-tape copying capability, while simultaneously preparing an APS-4 composition tape.

Line Printer -- To support the editing and composition system, a line printer with at least a 96-character set (full ASCII upper and lower case), capable of printing 132 columns at a minimum rate of 200 lines per minute, should be used. Preferably, the printer should have a tape controlled formatting capability.

CRC -- The present APS-4 is more than adequate for the NSDSA production requirements for the next four to six years.

Microfiche -- At present, the NSDSA uses the local NPPSO facilities to produce microfiche for approximately 300 users, as a part of the Shipboard Microfiche Test (SMT) program. The production is straightforward; CRC is photographed by a step-and-repeat camera to produce a master microfiche. The master is then copied to produce the required number of duplicates for distribution to the users. Currently, the volume is low, because the program is still more or less in the evaluation stage. There is every indication that the program will expand rapidly, probably during the next three to four years. If so, then the production of microficne should change methods. With the presence of an automated document production system and volume requirements, direct magnetic tape-to-microfiche techniques should be employed.

The APS-4 can be adapted to produce roll microfilm instead of CRC; it cannot be adapted to the production of microfiche. However, there are a number of devices available today that do produce microfiche directly from a properly prepared magnetic tape. These devices are fairly expensive ($60,000 to $120,000), so they should only be considered in a high volume production situation. Since the current production is only approximately 200 microfiche masters per month (about ten per day), it is more cost effective to photograph CRC. The impression gathered from the NSDSA personnel involved in the SMT program is that it will probably be two to four years before the volume of

production can warrant the use of direct production of microfiche from composition tapes. Assumming a one year installation and shakedown period, somewhere between one and three years from the date of this report, the NSWSES should complete plans to add such a device to the automated document production system, if full MOTD production is still conducted there and the microfiche volume requirements materialize as predicted. It should be noted that the microfiche masters produced at the NSWSES would be the equivalent of the present APS-4 produced CRC. The local NPPSO would use these microfiche masters to produce the required distribution copies.

Fortunately, any microfiche production device will operate in an off-line fashion, as does the APS-4. Therefore, the major adaptation that will be required will be additions to the text composition system software to accommodate the microfiche system characteristics. This emphasizes the value of obtaining a general modularly composed software package, where such additions are relatively easily made.

Image Digitizing Devices -- It is our professional opinion that at present there is no cost effective way of digitizing, storing, and directly updating illustration material. There are one-of-a-kind systems in existence, one or two of which appear promising. However, most of the emphasis to date has been placed on digitizing devices and not on complete systems. The results are that, when viewed as a system with very modest retrieval requirements, a well organized manual system such as exists at the NSWSES is very cost competitive. At this writing we cannot make a convincing arguement to change that system.

Format Conversion Devices -- At present, almost all of the raw MOTD is in handwritten or typewritten form. At this writing, there were discussions regarding the possibility of accepting MTST tapes as machine-readable input. We strongly advise against this, as far as

ADPREPS is concerned. The cost of providing a service to translate the MTST tapes into true machine-readable tapes is prohibitive unless a large volume of activity is encountered. To do so at the NSWSES would probably involve the FACSO IBM 370 computer, a step in the opposite direction to consolidation of the NSDSA MOTD production at the NSWSES.

The provision of OCR font copy should be avoided for the present, for the same reasons plus the lack of quality control that the NSDSA will be able to maintain over the suppliers, given the present contractual conditions.

Perhaps NAVSEA, being a very large customer, should consider the establishment of a media translation center where data in various formats and media can be translated into a well defined, standard machine-readable magnetic tape for use by activities such as the NSDSA. Certainly, such a facility would be more efficient since it would be handling more volume than, say, the NSDSA facility. Therefore, such a center could economically justify several different translation devices easily. As stated previously, there is at present a serious lack of standards for performance in the area of data capture devices. This lack makes the use of data produced by such devices difficult for other than users of similar devices.

d. Replacement System Configuration

For the near future then, any replacement of ADPREPS should be composed of two systems, one for data capture and one for editing and composition. Figure III-1 is a block diagram of the suggested replacement systems, with the dashed lines indicating future growth possibilities. As discussed above, consideration should be given to the possible addition of a device for producing microfiche masters when the volume of such work warrants the addition. Since it will

operate off-line, it is not considered in the configuration. The magnetic tape capability will suffice for either the APS-4 or a microfiche production device, or both.

e. Replacement System Costs

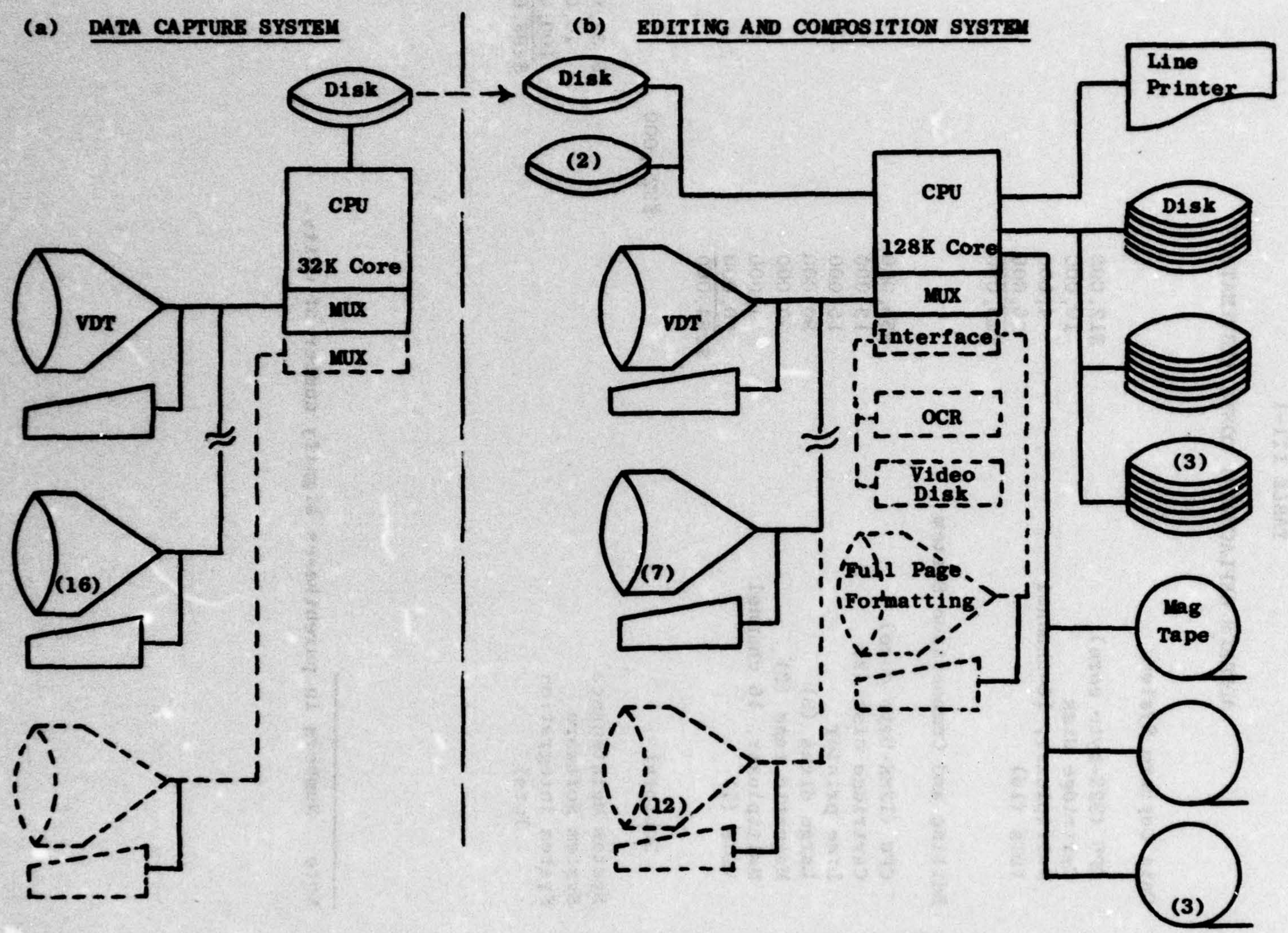
Based on representative catalog prices for the equipment shown in Figure III-1, the cost breakdown shown in Table III-1 is obtained. It is emphasized that these are representative costs and will vary from vendor to vendor. We believe that the average cost for the entire configuration should not vary more than 15% from the total shown.

Based on these costs, and referring once more to Table D-1, we can derive the approximate page costs for operating this replacement system. Again, Table D-1 costs have been adjusted to reflect a 20% increase in productivity (Item 3), and the replacement of Items 5 and 8 by the new system components. We will assume that the system is producing 5,000 new pages of CRC per month. Dividing the total purchase price by 40 months, a representative amortization period for this equipment, results in a projected monthly fixed cost of $12,465. Of this, $3,500 is caused by the software and the system integration costs.

The costs are projected to be:

Fixed	Variable
$12,465 + $6,400 + $6760/5000 pages +	$77.91 per page = $80.40/page

It is seen that this is approximately half of the present cost determined during the investigative phase reported in Appendix D. Again, the important thing to note is that the equipment itself



Note: Numbers in parentheses signify number of units.

Figure III-1 SUGGESTED ADPREPS REPLACEMENT SYSTEM

TABLE III-1

ADPREPS REPLACEMENT COSTS (ESTIMATED)

Data Capture System			
CPU (32K-byte core)	$12,000		
Cartridge disk	10,000		
Multiplexer, 16-channel	4,000		
VDTs (16)	36,000		
	$62,000		
Editing and Composition System			
CPU (128K-byte core)	$55,000		
Cartridge disk (2)	15,000		
Line printer	15,000		
Large disks (3)	90,000		
Magnetic tape (3)	35,000		
Multiplexer, 16 channel	4,000		
VDTs (7)	50,000		
	$264,000		
Subtotal		$326,000	
System Maintenance			$ 32,600
System Software			40,000
System Integration			100,000
Total			$498,600

Note: Numbers in parentheses signify number of units.

represents only a little more than 3% of the total cost; anything that can be done to increase personnel efficiency will have a large effect on the costs.

E. Replacing ADPREPS with Contractor Services

At the beginning of project work it was planned to gather specific data regarding typical prices that contractors charge the Navy for MOTD production work. It became apparent during our attempts to do so that this was a very sensitive subject with the contractors. In retrospect, perhaps we should have recalled the reluctance of most of the contractors to discuss production costs during the investigations for the first part of this contract. As a typical example, at the suggestion of SEA 046, we visited a particular vendor that supplies automated MOTD production services to the Navy. Although we recieved a cordial reception, they were unwilling either to show any work in production or to discuss prices on any basis. With minor variations, the experience was repeated several times. It was also repeated a number of times that this is a highly competitive area and that cost information is a closely guarded secret with most vendors.

There is information of less validity and accuracy from which to form at least an educated estimate of such costs. First, several years ago, the SRI project staff was engaged in a project that required the production of 30,000 pages of mostly textual material for a client by a large commercial typesetting company. For this job, a page was considered to be 6,000 alphanumeric characters, as compared to the NSTM page of 5,000 characters. For the job, working from a magnetic tape prepared by the client, the cost for a cycle of galley proof-page proof-final CRC (produced on a phototypesetter with capabilities similar to those of the APS-4) varied between $25 and $40 per page. Adjusting this to today's prices and the smaller NSTM page, the cost today for the same

services should be between $30 and $48 per page for the single complete pass. Again, it should be noted that the client supplied the input data in machine-readable format and the job was a very large single contract.

Second, there is the information reported in Appendix D regarding the NSDSA costs for outside MOTD production. Although this price information also includes costs for engineering services, even if 60% of the total cost is allocated to the engineering function, the resulting cost is still in the vicinity of $80 per finished page of CRC.

Third, as also discussed in Appendix D, there is the NPPSO cost sheet for estimating the costs for automated document production. As was discussed, there are many caveats to be observed when using that document. However, if we attribute to that system the same requirement that we have to ADPREPS to go through the cycle three times, then we can expect a minimum cost of approximately $55 for each finished page of CRC.

Although the above information certainly cannnot be labled highly definitive. We do believe that it is reliable and representative enough to assume that for NSTM-like material, if done completely by a contractor, the NSDSA should expect to pay between $60 and $80 per finished CRC page. It should be noted that this is the price of the contractor's efforts only, and does not include the NSDSA costs for liaison, delays, reviews, and control.

Figure C-1 in Appendix C shows that there are large existing requirements for the NSDSA to provide liaison and control functions to obtain final approved CRC. Perhaps even more important is the fact that each step requiring liaison or control is time consuming and a potential delay in the production schedule. During the course of the project, there was ample opportunity to observe the negative effects of missed mailings, misunderstood telephone conversations, differences of opinion as to a definition of requirements, and similar unexpected occurrences.

We also note that the problems of the present low monthly volume may not even be representative of the potential problems caused by a ten-fold volume increase in the future.

One possibility exists with regard to using contractor services. A contract could be entered into with one contractor exclusively, on a long term basis. This would allow the chosen contractor to confidently obtain a system equal to that described as a replacement for ADPREPS. Under such conditions, the NSDSA would probably have to permanently locate personnel at the contractor's location. We do not know what the legal contractual limitations are concerning an exclusive contract for, say, a four or five year period, but it is probable that there are some. Making allowances for the same relative efficiency between the NSWSES staff and an equivalent contractor's staff, and for the extra required liaison by the NSDSA, the total price to the NSDSA for services under this arrangement should be no less than and perhaps slightly higher than those projected for the ADPREPS replacement system. A significant detraction to this arrangement is the loss of direct control that the NSDSA would experience as opposed to that resulting from performing the work at the NSWSES.

F. Converting ADPREPS To a Data Base Maintenance System

A third possibility is that of using the replacement for ADPREPS solely as a data base maintenance system. This would require three things; first, that the data capture system be considered temporary; second, that negotiations begin immediately with vendors who are scheduled to prepare new MOTD to have them deliver it in the form of a 9-track magnetic tape acceptable to the data editing and composition system; and third, that the same negotiations begin with vendors who will be needed to capture the present MOTD that is to be put in machine-readable form. When this approach is completely implemented, then the

There are some economies to this extension, mostly derived from the fact that the APS-4 production rate is so high that it could be used for other than just the NSDSA work. This will be particularly true if the APS-4 is no longer needed tp produce multiple proof copies, which would be the case with full-page on-line formatting. Under those conditions, assuming one proof in addition to the final CRC, the APS-4 could produce 1250 finished CRCs in a single eight-hour shift, or approximately 27,500 pages per 22-day work month. This exceeds the NSDSA requirements for the immediate future by a wide margin.

IV CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Based on the information gathered and analyzed to date, the following conclusions were reached.

(1) The ADPREPS system at the NSWSES is completely inadequate to support the NSDSA MOTD work load. In addition, it is not a cost effective system.

(2) There are current personnel shortages at the NSWSES that will affect the operation of any future automated document production system there.

(3) During the next three to four years, the NSDSA MOTD work load should expand to a rate of production equivalent to 5,000 to 8,000 finished pages of CRC per month.

(4) The immediate MOTD problem is the establishment of a machine-readable data base. For the next two to four years, the major method of preparing this data base will be by manual keyboarding.

(5) Because of the complex liaison and control problem that the NSDSA faces, there is no advantage to exclusive use of contractors to produce the required MOTD.

(6) Beyond the next two to four years, it is probable that sufficient standards and contractual arrangements will have been defined to make data capture in machine-readable form almost an exclusive contractor function. At that time the major task of the NSDSA support system will be data base maintenance and preparation of formatted files to produce CRC or microfiche.

(7) The manual methods of microfiche production for the NSDSA by the local NPPSO are in keeping with the low volume at present. After the establishment of a machine-readable data base, a device to produce microfiche masters directly from computer files will be more cost effective as high volumes are encountered.

(8) Due to the distance separating the NSDSA from the NSWSES automated document production system, there are unnecessary inefficiencies in the manner in which liaison and production control is handled between the two activities.

(9) Beyond three to four years, any additions to the ADPREPS replacement system should be defined within the NTIPP implementation.

B. Recommendations

As a result of the above conclusions, the following recommendations are made:

(1) Replace the ADPREPS with a facility having the capabilities described under alternative one (see Section III.B.). If the system is easily expanded, then perhaps the initial acquisition should be for ten data capture VDTs and five

editing VDTs, which would slightly lower the initial cost estimated in Table III-1. Additions would then be made as volume and personnel become available.

(2) Alternative three (see Chapter III.F.) should be viewed as an attractive future course of action. The NSDSA should begin immediately to develop specifications for standard formatted 9-track data tapes to be required of the various contractors. Separate contract periods for the data capture and the editing and composition systems should be considered for the replacement facility. If alternative three is followed completely, a full page on-line formatting capability should be added to the replacement system before the APS-4 phototypesetter is released for any other use.

(3) As soon as possible, acquire a Branch Supervisor to manage the present ADPREPS and any new facility.

(4) As soon as possible, acquire a second software system person to assist and back up the present person. Use both of these persons, with NSDSA participation, to design and control an enlarged data management function for the NSDSA MOTD.

(5) Initiate the actions necessary to specify the requirements for the additional production personnel that will be needed to operate an expanded document producion facility.

(6) The possibility of bringing the present Code 5700 personnel in closer proximity to the NSDSA personnel should be seriously considered. We recognize the difficulty of making such arrangements, but its potential value is significant. If, as appears likely, the NSDSA staff is enlarged significantly in the near future, perhaps one alternative would be to assemble

the NSDSA staff responsible for the production work--as opposed to the planning and STEPS file management functions--nearer to the document production facilities. Another possibility would be to prepare a new location for the installation of the ADPREPS replacement that is nearer to the NSDSA location. This would offer uninterrupted parallel operation of ADPREPS and the replacement system, as well as bringing the two major participants in the work closer together.

(7) With the exception of additional VDTs to handle increased volume, and the possibility of adding a full-page on-line editing capability to the replacement for ADPREPS, any additional major equipment acquisitions should be deferred until the guidelines for the NTIPP are more clearly identified. The one exception to this might be the addition of a magnetic tape-to-microfiche device, but even here the probable required date is at least two years away.

Appendix A

NAVSEA TECHNICAL MANUAL ANALYSIS

Appendix A

NAVSEA TECHNICAL MANUAL ANALYSIS

1. Introduction

An analysis of the nature, quantities, and usage of technical data, particularly technical manuals, under the cognizance of the Naval Sea Systems Command has been made, based on readily available information and data. Emphasis has been placed on maintenance and operations technical data within the scope of the Naval Sea Data Support Activity (NSDSA), to produce an analysis which is applicable to the consideration of the ADP augmented publishing and inventory information systems for that Activity. Thus, although the relationship of 3 M documentation to NAVSEA technical manuals is discussed, that documentation has not been subjected to analysis. Also, technical data concerning nuclear propulsion systems are not treated.

Technical manuals constitute the bulk of the technical data of concern and represent the greatest cost to prepare, publish, review, and update, with the possible exception of ships' drawings. The number of technical manuals in inventory is constantly changing, as ships and equipment are phased in or out of the active Navy. There are at this time approximately 95,000 NAVSEA teachnical manuals,[1] depending somewhat on how these are defined in relation to other technical data and information. Our definition included maintenance and operation manuals, information books, lubrication charts, and other documents generally covered by Section 086 of the General Specifications for Ships of the United States Navy.[2] We excluded temporary changes, field changes, and information bulletins issued on a periodic basis. As a concrete example, among ordnance data, we included Ordnance Publications (OP) but not Ordnance Data (OD).

A technical manual, as used here, is a technical document. Many such manuals are part of a set of volumes pertaining to a particular equipment or system. In these cases, each volume is regarded as a separate technical manual. The NAVSEA technical document numbering system is in the process of being changed. However, in the system extant during SRI's analysis, ships' manuals are numbered separately, volume by volume. This is not true of ordnance publications. The sample data available to us indicate that the average NAVSEA technical manual contains 203 pages and 82 illustration. Many of the pages are foldouts, so that the number of page units (8" by 10 1/2" or 8 1/2" by 11") averages 265 per manual. These facts are not very meaningful, except to indicate that, in total, there would appear to be some 23 million page units, 17 million pages, and 7 million illustrations in a complete set of NAVSEA tehchnical manuals.

To set forth more usefully the character of NAVSEA technical manuals, we describe a number of key dimensions that would appear pertinent to the design of future automated publishing and inventory systems.

2. The Equipment Dimension

Most NAVSEA technical manuals pertain to particular systems and pieces of hardware. Equipment complexity varies among hull, mechanical, electrical, electronic, and ordnance items. Generally, the more complex equipment is accompanied by more numerous, more voluminous, and more complicated technical manuals. It is therefore useful to analyze the NAVSEA technical manual inventory by classes of equipment. Fortunately, document identification numbers contain an "equipment code" that permits such analysis. Table A-1 shows the complete code, and also the number of manuals in the inventory.

TABLE A-1

NAVSEA EQUIPMENT CODES

Material Group	Code	N*	Material Group	Code	N*
General	00	725	Ship Control	24	1558
Naval Ships' Technical Manual	01	255	Towing Equipment	25	37
Vessel Conversion Documents	02	90	Mooring Equipment	26	391
Ship Readiness	03	61	Seaworthiness	28	1
Technical Manual Index	04	123	Stability	29	41
GIB, SIB,POG, etc.	05	6481			
Launching, Allowance Lists	06	51	Storerooms	30	31
Docking	07	13	Repair Parts	31	14
Trials	08	7	Office Spaces	32	37
Fabrication Processes	09	1	Living Spaces	33	177
			Commissary	34	2906
Hull Structure	11	7	Laundry	35	1021
Hull Fittings	12	103	Sanitation	36	428
Armor Protection	13	†	Medical and Dental	37	357
Deck Coverings	14	†	Ventilation	38	818
Aircraft Fuel Stowage	15	171	Insulation	39	3
Access, Conveyors, Elevators	16	470			
Mast, Booms, and Spans	17	180	Machinery Plant	40	979
Rigging, Sails, and Awnings	18	6	Main Propulsion	41	1987
Protective Coatings	19	48	Reduction Gears	42	207
			Shafts and Bearings	43	180
Winches, Capstans, Cranes	20	1842	Propellers	44	79
Hydraulic Speed Machinery	21	170	Lubrication Systems	45	588
Steering Machinery	22	580	Condensers and Air Ejectors	46	363
Industrial Gases	23	153	Pumps	47	6147

TABLE A-1 (Continued)

Material Group	Code	N*	Material Group	Code	N*
Piping Systems	48	2878	Armament of Ships††	73	18404
Compressed Air Plant	49	1046	Dual Purpose Gun Mounts	74	†
			Torpedo Handling	75	29
Auxiliary Machinery	50	566	Mines and Depth Charges	76	5
Boilers	51	870	ABC Defense Equipment	77	20
Uptakes and Smokepipes	52	3	Ammunition Handling	78	945
Blowers	53	237	Small Arms Handling	79	†
Fuel Handling and Stowage	55	344			
Feed-Water Equipment	56	233	Mine, Torpedo, Bomb Protection	81	832
Distilling Plants	58	504	Small Boats	82	240
Refrigerating Plants	59	1154	Aircraft Handling & Stowage	83	299
			Motion Picture Projection	85	252
Electric Plants	60	14	Training Apparatus	86	2
Electric Power Generation	61	1971	Indicating and Recording Instruments	87	826
Electric Power Distribution	62	2224	Damage Control	88	1416
Electric Motors	63	1122	Nuclear Reactors	89	1003
Lighting Systems	64	58			
Interior Communications	65	3288	Nuclear Protection	90	1
Searchlights	66	168	Workshop Equipment	91	3127
Electronics	67	12836	Portable Tools	92	654
Test Instrumentation	69	2375	Fire Fighting Equipment	93	538
			Salvage Equipment	94	124
Signaling Apparatus	70	111	Suspension Systems	96	10
Fire Control Installation	71	424	Heat Transfer Equipment	97	3
Turrets	72	†			

* Number of technical manuals in the NSDSA inventory.

† Not available.

†† Includes Ordnance Publications (OP).

As can be seen from Table A-1, the first nine categories refer to more general subjects that would be inferred from the term "equipment code." Following these, generally, the code numbers in the 10s pertain to hull items, the 20s to deck equipment, the 30s to habitation equipment, the 40s to main propulsion equipment, the 50s to steam-generating and auxiliary equipment, 60s to electrical and electronics categories, 70s to armament, and the remaining categories cover miscellaneous kinds of equipment.

An available source of information on the physical and content characteristics of NAVSEA technical manuals is the Technical Manual Deficiency Status Report issued periodically by the NSDSA. The most recent issue of this publication contains listings of well over 1000 technical manuals; physical and content characteristics are stated for a substantial fraction of these. Twenty six equipment codes are represented by a sufficient number of manuals to permit estimates to be made of the physical and content characteristics of the family of manuals within each code in the inventory. Together, the 26 categories represent about 68,000 manuals, or over 70% of those in the inventory. The estimates of physical characteristics are shown in Table A-2. Shown are the subject areas, equipment codes, numbers of manuals in the sample, average numbers of pages, illustrations, and page units derived from each sample, and a measure of variability of the sample average or mean from the population mean.

The measure of variability shown in the final column of Table A-2 was computed for the average number of pages in each sample. It may be interpreted, with reservations, as the standard deviation of the population mean from the observed sample mean; that is, the average number of pages for all manuals pertaining to the equipment code is expected to lie within plus or minus the stated percentage of the sample average with a probability of about 0.68. The major reservation concerning this measure of variability is that it is strictly applicable

TABLE A-2

PHYSICAL CHARACTERISTICS OF A SAMPLE OF NAVSEA TECHNICAL MANUALS

Subject Area	Code	N*	Average Pages	Average Illustrations	Average Page Units	Variability†
General	00	11	151	79	202	33%
NSTM	01	94	35	17	35	16%
GIB, SIB, POG, etc.	05	22	259	65	359	9%
Access, elevators	16	14	177	67	282	29%
Winches, cranes	20	77	206	95	300	6%
Steering machinery	22	20	153	65	246	9%
Industrial gases	23	38	161	63	187	10%
Ship control	24	57	218	89	313	9%
Stability	29	8	209	90	279	20%
Ventilation	38	10	111	33	124	30%
Main propulsion	41	44	286	101	396	9%
Reduction gears	42	6	183	100	291	21%
Pumps	47	23	67	21	80	19%
Piping systems	48	15	350	83	536	20%

TABLE A-2 (Continued)

PHYSICAL CHARACTERISTICS OF A SAMPLE OF NAVSEA TECHNICAL MANUALS

Subject Area	Code	N	Average Pages	Average Illustrations	Average Page Units	Variability
Compressed air systems	49	32	229	76	286	8%
Boilers	51	59	224	118	287	8%
Generators	61	29	317	153	428	10%
Power distribution	62	42	108	45	127	17%
Motors	63	45	172	68	243	11%
Interior communications	65	25	202	66	256	32%
Electronics	67	114	242	110	328	9%
Armament of ships	73	54	207	88	220	10%
Torpedo handling	75	12	186	41	189	9%
Ammunition handling	78	69	151	62	244	19%
Mine,torpedo, bomb protection	81	6	178	83	213	20%
Aircraft handling & stowage	83	13	324	168	526	15%
Overall averages			203	82	265	

*N is the number of technical manuals in the sample.

†Variability is the standard deviation of sample mean from the population mean for the sample size, given a large population.

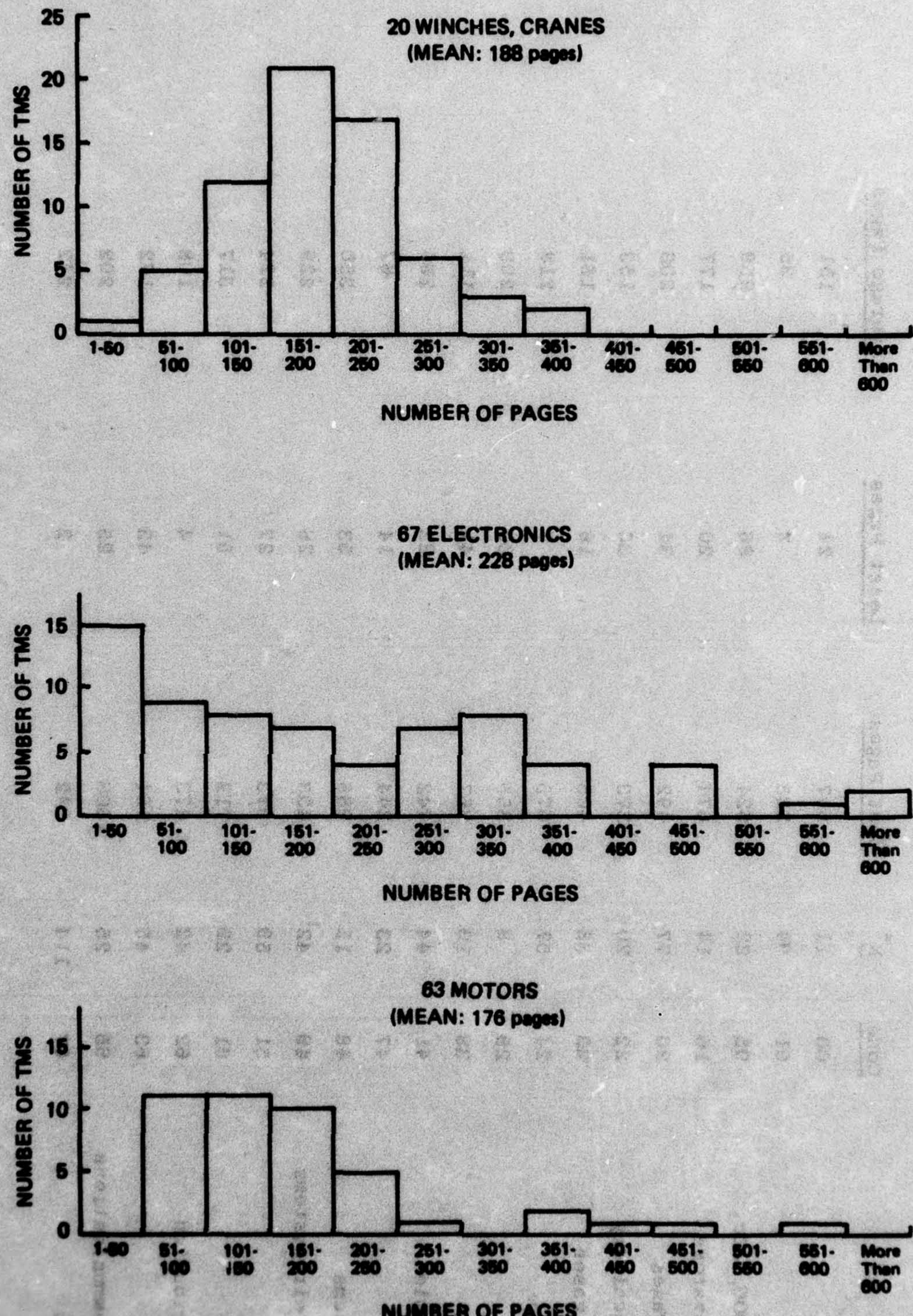


Figure A-1 DISTRIBUTIONS OF THREE SAMPLES

TABLE A-3

RANGE DATA FOR A SAMPLE OF NAVSEA TECHNICAL MANUALS
(Number of Pages)

Subject	Code	N*	Most Pages	Least Pages	Average Pages
General	00	11	557	24	151
NSTM	01	94	223	2	35
GIB, SIB, POG, etc.	05	22	524	86	259
Access, elevators	16	14	674	20	177
Winches, cranes	20	77	492	34	206
Steering machinery	22	20	273	35	153
Industrial gases	23	38	405	16	161
Ship control	24	57	575	7	218
Stability	29	8	355	20	209
Ventilation	38	10	367	41	111
Main propulsion	41	44	742	22	286
Pumps	47	23	244	14	67
Piping systems	48	15	985	53	350
Compressed air systems	49	42	433	25	229
Boilers	51	59	573	27	224
Generators	61	29	712	51	317
Power distribution	62	42	473	4	108
Motors	63	45	564	43	172
Interior communications	65	25	1308	25	202
Electronics	67	114	942	2	242

TABLE A-3 (Continued)

Subject	Code	N*	Most Pages	Least Pages	Average Pages
Armament of ships†	73	54	645	48	207
Torpedo handling	75	12	223	44	186
Ammunition handling	78	69	968	8	151
Aircraft handling & stowage	83	13	743	169	324

*Number of TMs in the sample.

†Includes Ordnance Publications.

overhaul, and replacement programs for each generic family of equipment. Each chapter is to reflect the latest (as well as older) materials, equipments, systems, and procedures in general use. This poses a continuing updating task. Additionally, there is a requirement for close correlation between the maintenance information in the NSTM and the Maintenance Requirement Cards (MRCs) discussed later.

As can be seen in Table A-3, the size of NSTM chapters ranges from 2 to 223 pages. Since the average is 35 pages, only a few chapters have large numbers of pages. In general, the dimensions of the NSTM chapters are a measure of the complexity of the equipments, systems, or operations covered. The largest chapter (223 pages) concerns damage control. The next largest (160 pages) concerns boilers. Chapters on electrical equipment are also in the large category.

3. The Ship Dimension

The essential purpose of NAVSEA technical data is to provide a basis for fleet readiness -- materiel readiness, to be precise. This means that the dominant concern is with the ships of the fleet, whose crews are also primary users of the technical data. There are currently approximately 470 ships in active status, each with a "suit" of technical data essential to its maintenance and operation. This suit is quite extensive. One typical combatant ship, the USS Henry E. Yarnell, DLG 17, requires about 6500 data items. Of these, about 2200 are technical manuals. The remainder are variously temporary and field changes, technical information bulletins, lists, maintenance cards, and program tapes. Thus, simply identifying the technical data that should be on board a typical ship is a nontrivial task. For this purpose, a Technical Documentation Index (TDI) is prepared by the NSDSA. The TDI is a listing of the technical data available to support the operation, testing, and maintenance of on board systems, sub systems, and

equipments under the technical cognizance of NAVSEA and NAVELEX. Ship TDIs are tailored to the particular ship. During FY 1976, the NSDSA issued about 6600 TDIs, their largest category of output.

Technical manuals for shipboard use are governed by the provisions of Section 086 of the General Specifications for Ships of the United States Navy.[4] Subordinate specifications must be consistent with the General Specifications, which are specific only for the major publications peculiar to each ship. The most inclusive is the Ship Information Book (SIB). It consists of seven volumes, some with several parts, covering hull and hull mechanical systems; machinery plant; power and lighting systems; electronic systems; interior communication systems; weapons control systems; and ballasting systems. The first volume includes a general description of the ship's design characteristics and the major shipboard arrangements and systems. The remaining volumes describe specific systems, interrelationships among systems, trouble shooting, fault isolation techniques, system check out, and routine system maintenance. Descriptive text, lists, and illustrations are included as necessary. However, information in the NSTM and in equipment manuals is not repeated, except as necessary to fulfill the intent of the text.

Related to and augmenting the SIB are the following series of technical manauals:

- Propulsion Operating Guide (POG), which is for the guidance of operating personnel in monitoring propulsion operating conditions. The POG is often a condensed version of Volume 2 of the SIB, with many sketches and flow diagrams. It is used extensively in the training of crews.
- Central Control System Manual, which covers the maintenance and operation of the main ship control equipment and consoles.

- Operational Stations Book.
- Weapon Control Intrasystem and Intersystem Alignment Procedures Manual.
- Training Aid Book, which is a pocket sized assembly of diagrams, without text, of the ship's piping, electrical, and electronic systems, with drawings of the more complicated equipment.
- Stores Handling and Fueling-at-Sea System Manual.
- Weapon System Handling and Stowage Manual(s).
- The Damage Control Book and Compartment Checkoff Lists.

The equivalent set of manuals for submarines and for nuclear powered surface ships is analogous to that described.

Most of the ship specific manuals described above are indexed under equipment code 05, for which sample data are given in Tables A-2 and A-3. Exceptions are the Training Aid Book, assigned to code 03, and the Damage Control Book, to code 88. Data are not available on manuals in these categories.

4. The Ship Life Cycle Dimension

Much of the demand placed on the NAVSEA technical data system can be best understood by considering the life cycle dimension for the typical ship. The average life of a naval ship can be taken to be 30 years for this purpose. The initial assembly of the ship's technical data occurs during building, outfitting, and trials. One product is the Technical Manual Index (TMI). The TMI is a listing of all contractor furnished and Government furnished TMs--including known planned post

construction NAVSEA/NAVELEX equipment intended for the ship. Thus, it goes beyond the availability index, the TDI. The original TMI is prepared by the shipbuilder and updated until the ship is accepted by the Navy, at which time the ship's TMI is provided to the Overhaul Yard for use and future updating. Similarly, on all ships over 200 feet in length there is a Ships Drawing Index (SDI) prepared by the shipbuilder, which is a list of ship drawings and related design information that shows the current configuration of the ship. For ordnance items, technical data are listed in the Publications Requirements List (PRL). After acceptance of the ship by the Navy, the SDI is forwarded to the selected Planning Yard, which is assigned as custodian of the index. Generally, the Planning Yard designation is unchanged for the life of the ship, whereas the assigned Overhaul Yard may change, depending on the fleet and geographic assignments of the ship.

All ship systems and equipment under NAVSEA cognizance must be supported by technical manuals. When a ship is to be built, the procurement of these manuals is incorporated into the acquisition process and included in the costing. A technical manual plan is developed as early as practicable. The process culminates in a Technical Manual Requirements List and an associated Contract Data Requirements List (CDRL) incorporated in the contract documents. The technical manuals procured with a new ship, particularly the first of a class, are subject to a quality assurance process consisting of in process review (IPR) team that reviews the technical manual outline and book plan and the manuscript at suitable intervals, to identify deficiencies to be corrected. The shipbuilder or other preparing activity validates by comparing data and illustrations with the hardware and performing procedures. Verification is normally accomplished at a Navy facility having the same maintenance capability level as that covered by the technical manual being verified. Under some circumstances, it is accomplished by witnessing the validation process and by analyzing the preparer's data and test records.

Acceptance of technical manuals consists of two phases: preliminary and final. Manuals with preliminary approval have been validated, but not verified. They are to be delivered prior to the arrival of the precommissioning crew. Final (verified) manuals are to be delivered prior to completion of Post Shakedown Availability, which is a repair period after trials, but not later than the end of the guarantee period. The initial procurement of technical manuals appears to be the critical stage. If inadequate or deficient manuals are procured, their correction or revision becomes a burden on the Navy's operating and maintenance processes that is not easily met. Except for simple equipments, such as those used in housekeeping aboard ship (codes 30-37), all technical manuals must meet the requirements of an approved military specification (such as MIL M-15071 or WS-10759) and associated standards. At the same time, maximum use of commercial manuals has been encouraged in the past provided that they reflect the installed hardware, are compatible with Navy maintenance concepts, and are geared to the personnel who actually will operate and maintain the equipment. This practice may encourage the procurement of substandard technical manuals. Many of the manuals listed in the deficiency report as deficient are asserted to be "no more than a collection of manufacturers' brochures." The correction of deficiencies of this kind is a difficult and costly task.

A naval ship's configuration usually continues to be changed throughout its life cycle, because of improvements in technology or remedied deficiencies. The key event in this process is overhaul, an extended period of availability in a shipyard, which generally occurs every four or five years. Most major changes, additions and deletions of equipment, and armament alterations occur during overhaul availability. There is a corresponding need to revise the ship's suit of technical manuals. For new equipments and systems, approved preliminary manuals must be delivered prior to the start of overhaul. Final manuals must be delivered before the completion of overhaul. The systems manuals, such as the SIB, and POG, must be updated by the

Overhaul Yard and returned to the custody of the ship. Affected plans and drawings must be revised and provided to the Planning Yard. And, of course, this spurt of changes must be reflected in the TDI and in various supply and maintenance management documents. For the publications system, this spurt of changes is but one of many, there being perhaps 100 ships undergoing overhaul annually.

Other changes can occur between scheduled overhauls in the course of approved shipboard changes, periodic availabilities at such intermediate maintenance activities (IMAs), as tenders and repair ships, and as the result of operating casualties. Since the policy[5] is that no hardware installation or modification is to be made without normally changing the affected technical manuals, these changes pose a substantial updating problem.

5. The Maintenance Process Dimension

NAVSEA technical manuals and other data provide information on both operation and maintenance of shipboard equipments and systems. Effective maintenance is a crucial element of material readiness. Materiel maintenance is of two kinds: planned and corrective. Planned maintenance is preventive in nature; actions are the minimum required to keep the equipment in a fully operating condition, within design specifications and to identify parts requiring replacement. Corrective maintenance, as the name implies, involves the correction of failures after they occur.

Both planned and corrective maintenance occur on board ship, although planned maintenance is preponderant. Since many failures cannot be corrected by the ship's crew, most of the corrective maintenance (and little of the planned maintenance) is done by supporting facilities tenders, intermediate maintenance activities (IMA), and repair yards.

Emphasis is on planned maintenance since it minimizes the amount of corrective maintenance needed. The major innovation in this area is the 3 M program,[6] which consists of a Planned Maintenance System (PMS) and an associated data acquisition process, called the Maintenance Data Collection System (MDCS). PMS procedures -- and how frequently they are to be performed -- are developed on the basis of good engineering practice, practical experience, technical standards, and, of course, the guidance in the technical manuals for the equipment. Cards or plasticized sheets, called Maintenance Requirement Cards (MRCs), contain the detailed procedures for performing the particular planned maintenance actions. Some MRCs are accompanied by Equipment Guide Lists (EGLs) that indicate the location on board of identical equipment requiring the same maintenance action. For each item of equipment in the PMS, there is a Maintenance Index Page (MIP) that lists each MRC pertaining to that equipment, a brief of its maintenance requirements, a periodicity code indicating how often the action is to be taken, and the skill level and man-hours needed, all of which are necessary for work scheduling.

For new equipments and systems, the PMS documents (MIPs, MRCs, and EGLs) are procured along with the hardware, as are the TMs. For equipment in service being brought into the PMS, these documents must be developed on the basis of the TMs, maintenance guides in the NSTM chapter, and practical experience. Considerable updating is required to maintain these various planned maintenance documents in a consistent way. One source of information for correcting or updating the technical documentation is the PMS feedback report. One category of feedback report is used to flag discrepancies between PMS documentation and the installed equipment, or between the PMS documents and the technical manuals associated with the equipment.

One consequence of the introduction of the 3 M program has been that technical manuals are no longer used directly in performing planned

maintenance. The principal inputs are now the MIPs, MRCs, and EGLs. Technical manuals, test equipment manuals, parts lists, and schematics are mainly used for operation, and especially for corrective maintenance. This emphasis is reflected in the TMSR, in which a survey of deficiencies in three typical equipment codes indicates that from 55% to 75% of the descrepencies are for inadequate or missing trouble-shooting information.

Approximately half of the TMs reviewed in the TMSR are considered deficient in some respect; the remainder are considered acceptable. In addition to information on physical characteristics (illustrations, pages, and page units), information is given on the number of pages devoted to operation, maintenance, and troubleshooting. Table A-4 summarizes the average number of pages in each category for the major sample codes. It can be seen that, on the average, pages of information on operation, maintenance, and troubleshooting constitute only about 40% of the total. The remainder are presumably given over to the other kinds of information found in TMs, general information and safety precautions, functional descriptions (including illustrations), parts lists, and installation instructions.

Another consequence of current fleet maintenance practices, in which technical manuals are used principally for corrective maintenance, is to increase the value of bringing together functionally related information in a particular chapter of the technical manual. This practice is now standard for new manuals. However, many manuals in the inventory are organized in an older way, with chapters devoted to functions or elements of the equipment, each chapter having its own operating, maintenance, and troubleshooting sections. Many of the deficiencies noted for correction in the TMSR include decentralized troubleshooting information.

TABLE A-4

CONTENT CHARACTERISTICS OF A SAMPLE OF NAVSEA TECHNICAL MANUALS

Subject	Code	N*	Average Total Pages	Average Number of Pages: Operations	Maintenance	Troubleshooting	Ratio†
General	00	11	151	4	30	38	0.48
NSTM	01	94	35	- - - - - - - - -	-NO DATA-	- - - - - - - - - - -	- - -
GIB, SIV, POG, etc.	05	22	259	24	25	42	0.35
Access, elevators	16	14	176	7	18	14	0.22
Winches, cranes	20	77	206	10	37	16	0.31
Steering machinery	22	20	153	7	27	9	0.28
Industrial gases	23	38	161	14	30	6	0.31
Ship control	24	57	218	34	59	41	0.61
Stability	29	8	209	12	20	8	0.19
Ventilation	38	10	111	21	14	22	0.51
Main propulsion	41	44	286	16	62	8	0.30
Reduction gears	42	6	183	18	12	12	0.23
Pumps	47	23	67	3	10	4	0.25
Piping systems	48	15	350	4	33	7	0.13

TABLE A-4 (continued)

Subject	Code	N	Average Total Pages	Average Number of Pages: Operations	Maintenance	Troubleshooting	Ratio
Compressed air systems	49	32	229	21	55	16	0.40
Boilers	51	59	224	29	51	14	0.42
Generators	61	29	317	13	69	11	0.29
Power distribution	62	42	108	9	13	3	0.23
Motors	63	45	172	9	21	14	0.26
Interior communications	65	25	202	10	50	25	0.42
Electronics	67	114	242	29	57	69	0.64
Armament of ships	73	54	207	68	34	43	0.70
Torpedo handling	75	12	186	118	31	22	0.92
Ammunition handling	78	69	151	15	19	14	0.32
Mine, torpedo, bomb protection	81	6	178	26	99	52	0.99
Aircraft handling & stowage	83	13	324	23	42	7	0.22
Overall averages			203	22	40	25	0.42

*Number of TMs in the sample.

†Ratio of average number of pages on operations, maintenance, and troubleshooting to the average number of pages in the TM.

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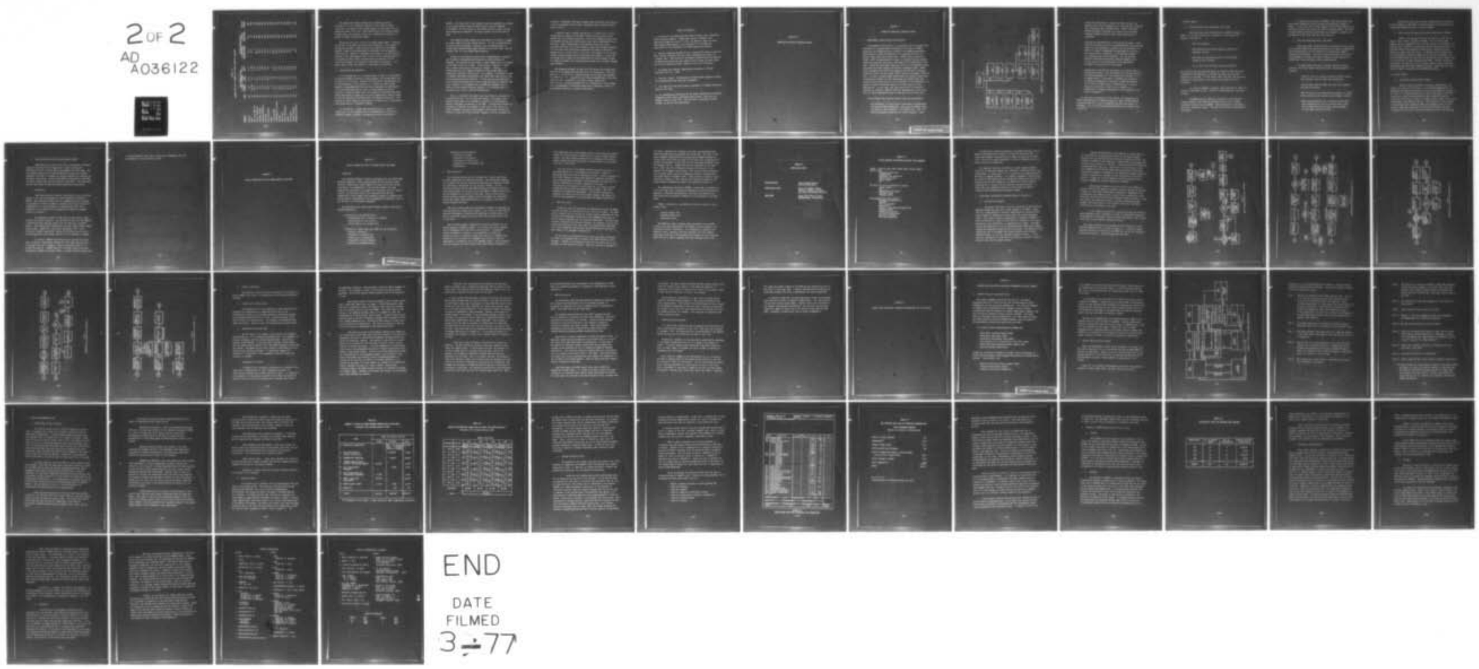

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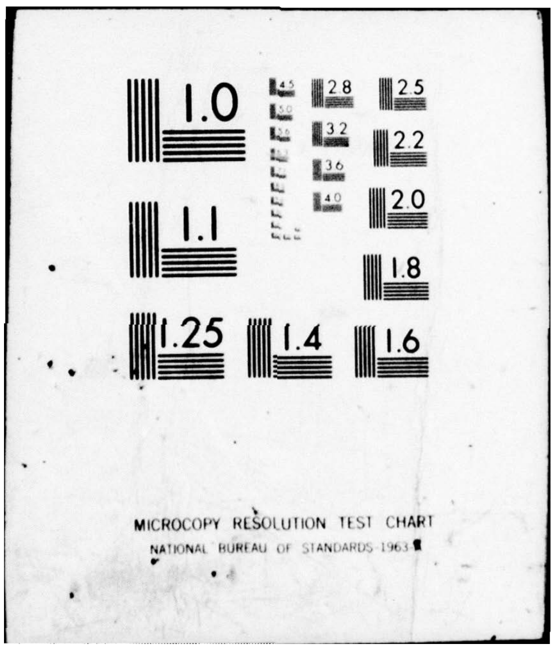
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TABLE A-5

CHANGE DATA FOR A SAMPLE OF NAVSEA TECHNICAL MANUALS

Subject	Code	Past Change History: Average Changes	Past Change History: Average Age	Past Change History: Annual Rate	Current Deficiencies: Average Page Changes Needed	Current Deficiencies: Average Page-Units	Percent Change
General	00	1.8	10.5	0.17	41.2	202	20%
NSTM	01	no data	5.7	no data	15.8	35	45%
GIB, SIB, POG, etc	05	25.9	5.7	4.54	0	348	0%
Access, elevators	16	5.9	10.1	0.58	127.3	350	36%
Winches, cranes	20	5.6	7.7	0.73	81.9	286	29%
Steering machinery	22	8.3	8.5	0.98	72.4	247	29%
Stability	29	2.5	6.9	0.36	113.6	279	41%
Main propulsion	41	19.2	10.6	1.81	41.7	429	10%
Pumps	47	0	9.6	0	12.7	100	13%
Piping systems	48	10.1	3.8	2.66	309.7	329	94%
Compressed air systems	49	2.7	7.0	0.39	133.3	329	41%
Boilers	51	10.5	7.4	1.42	36.2	387	9%
Generators	61	31.9	9.0	3.54	83.4	441	19%
Power distribution	62	6.4	9.6	0.67	20.8	191	11%
Motors	63	20.5	9.8	2.09	70.0	246	28%
Electronics	67	27.8	7.9	3.52	28.9	296	10%
Torpedo handling	75	0.3	5.0	0.15	0	161	0
Ammunition handling	78	9.6	11.6	0.83	55.0	242	23%

The right hand columns of Table A-5, related to current deficiences, are of a different character. With several notable exceptions, the number of page changes needed is much larger than the changes recorded in the past. When compared with the existing numbers of page units, they usually account for a substantial fraction of the manual, as shown in the final column.

These data may be the result of a highly biased sample. Certainly all entries in the TMSR result from some "flagging" of the content of the manuals recorded. These represent only about 1% of all NAVSEA manuals. There is no present means to determine how representative these data are. However, a sampling of the nature of the deficiencies recorded in the TMSR suggests that the data reflect updating needs of the second and third kinds; reorganization and expansion to meet utilization changes, and revision of substandard procurements. Such major rewrites imply the funding of "new" manual procurements.

7. Implications for Automation

If the average ages of the manuals shown in Table A-5 are weighted by the total number of manuals in each category, the average manual age is found to be 8.9 years. Assuming that this age is representative of the 95,000 manuals in the inventory, it follows that about 10,000 manuals are superseded each year by new or completely revised manuals. If it were determined that all new or revised manuals were to be procured in machine-readable form, the prospective automated publishing system would need to accept up to 3 million page-units--2 million pages of text and 850,000 illustrations--into its inventory every year. This presumes no major change in requirements, as might occur in a stepped-up fleet modernization or expansion program.

It follows that it would take the better part of a decade to convert more or less completely to the automated-mode, in which all permanent changes, revisions, and upgrading could be performed by

machine. The first half of the inventory could be assembled in a matter of 3-4 years, however; and this would include the most advanced technologies, the most dynamic or developing material groups, and the most change-prone categories, including selected record data and the NSTM.

The weighted average change rate from Table A-5 is about 2.5 pages per year, based on the past change history. If this is representative of NAVSEA technical manuals in general, then one should expect to process about 240,000 change pages annually of the first kind. This is somewhat over 1% of the manual page inventory.

Changes of the second and third kinds--reorganization, expansion, and revision of substandard publications--are more difficult to estimate. The weighted average number of page changes needed per manual in the TMSR is about 52.5 pages. (This average is based on a sample that includes many manuals requiring no changes.) However, it is evident that the total number of manuals in the current TMSR (964) represents a backlog of deficiencies. For example, if the TMSR includes all manuals with major deficiencies, one could infer that the other 99% in the inventory are not deficient. If this were so, one would expect only 100 deficient manuals out of the 10,000 entering the inventory each year. However, it is probable that the TMSR may represent only a portion of the actually deficient manuals. It is unlikely that it represents only a year's quota of deficiencies.

Thus, at a minimum, 100 manuals each year should be reflected in the deficiency file. At 52.5 pages per manual, 5,250 pages of new material would need to be processed, in addition to the backlog of nearly 51,000 pages represented in the TMSR. If funds were available to eliminate the backlog, for example in three years, there would be a total requirement for about 22,000 pages of new material during this period, or about 10% of the "routine" changes occurring throughout the

inventory. Thereafter, the major changes would constitute only about 2% of the total demand, and the total requirement would be about 250,000 pages annually.

A maximum figure is highly speculative, of course, but it is not unreasonable to assume that the TMSR reflects only one-third of the manuals that are currently deficient. Under this assumption, about 300 new manuals entering the inventory each year would be determined to be deficient. About 16,000 pages of new material would have to be processed each year, for a total demand of about 255,000 pages annually. It can be seen that uncertainties regarding the number of deficient manuals are not a major factor, since most of the demand is due to page changes reflecting corrections and configuration changes. In this area the change data of Table A-5 may undercount the actual changes by 50%. At 4 pages per manual, the updating process might need to handle 400,000 pages annually.

The foregoing estimates presume that the criteria for identifying deficiencies are essentially the same as in the recent past. There is a good deal of research and planning underway in the NTIPP and elsewhere on readability, work simplication, and format standardization that could result in major innovations in technical manual content and presentation. It can be presumed that for the most part, these changes would be introduced in new manual production as wholesale revision of the inventory would be an enormous undertaking.

NOTES TO APPENDIX A

1. A printout of the NSDSA data base dated 8 October 1976, identifies 59,227 technical manuals. Adding other manuals included in our definition brings the total to 74,582. In addition, there are about 4000 ordnance publications, with an average of 4.6 volumes per publication, or the equivalent of 18,400 single-volume manuals.

2. Specific reference was made to the 1 January 1974 version of Section 086, entitled "Technical Manuals," which superseded the version of 1 January 1973. This section of the General Specifications for Ships of the United States Navy has been updated several times in recent years, and the 1974 version was under revision at the time of analysis.

3. See Bowker and Liberman, Engineering Statistics, P. 378-383 (*Prentice- Hall Inc.*, 1959).

4. See note 2 above. The discussion of ship-specific manuals is drawn from paragraph 086d and subsequent paragraphs.

5. This policy has been most recently expressed in a *NAVSEA Instruction* dated 21 July 1976.

6. The promulgating instruction for the Ships' Maintenance and Material Management (3-M) system is OPNAVINST 4790.4 dated 1 June 1973, and Change 1 dated 29 April 1974. The 3-M Manual, consisting of three volumes, is part of this instruction.

Appendix B

PRODUCTION PROCESSES SUPPORTING NSDSA

Appendix B

PRODUCTION PROCESSES SUPPORTING NSDSA

1. NSWSES-NSDSA Organizational Relationships

For purposes of this report, it is important that the reader fully understand the organizational relationship that exists at NSWSES. Figure B-1 is a simplified block diagram of the NSWSES Organization. The Station as a whole is comprised of the Command Staff with its support codes, plus three Directorates. NSDSA itself, which has a current staff of approximately 75 people, is administratively located within the Logistics Directorate (Code 5000) and is identified as Code 5700. Mostly its operational funds are carried in the NAVSEA-04 budget with funds from other sources for specific designated tasks. NSDSA itself currently does not own nor manage any facilities for document production, other than the normal office typewriter equipment within its code. In order to produce MOTD, NSDSA funds Code 5600 for those items of production suitable for Code 5600 production capabilities, and contracts with outside vendors for the remainder of its production. At present, outside contracting supplies the great majority of the publications. At this time, most publication work is limited to updating and revision, together with data capturing for certain data that are being completely revised or generated for the first time.

Within NSDSA, there are three major divisions, dealing with:

- The maintenance of a data base of information that describes the status of MOTD NAVSEA-wide. These are the STEDMIS files, in process of being upgraded to the STEPS files. They are used for planning, production and control purposes. They

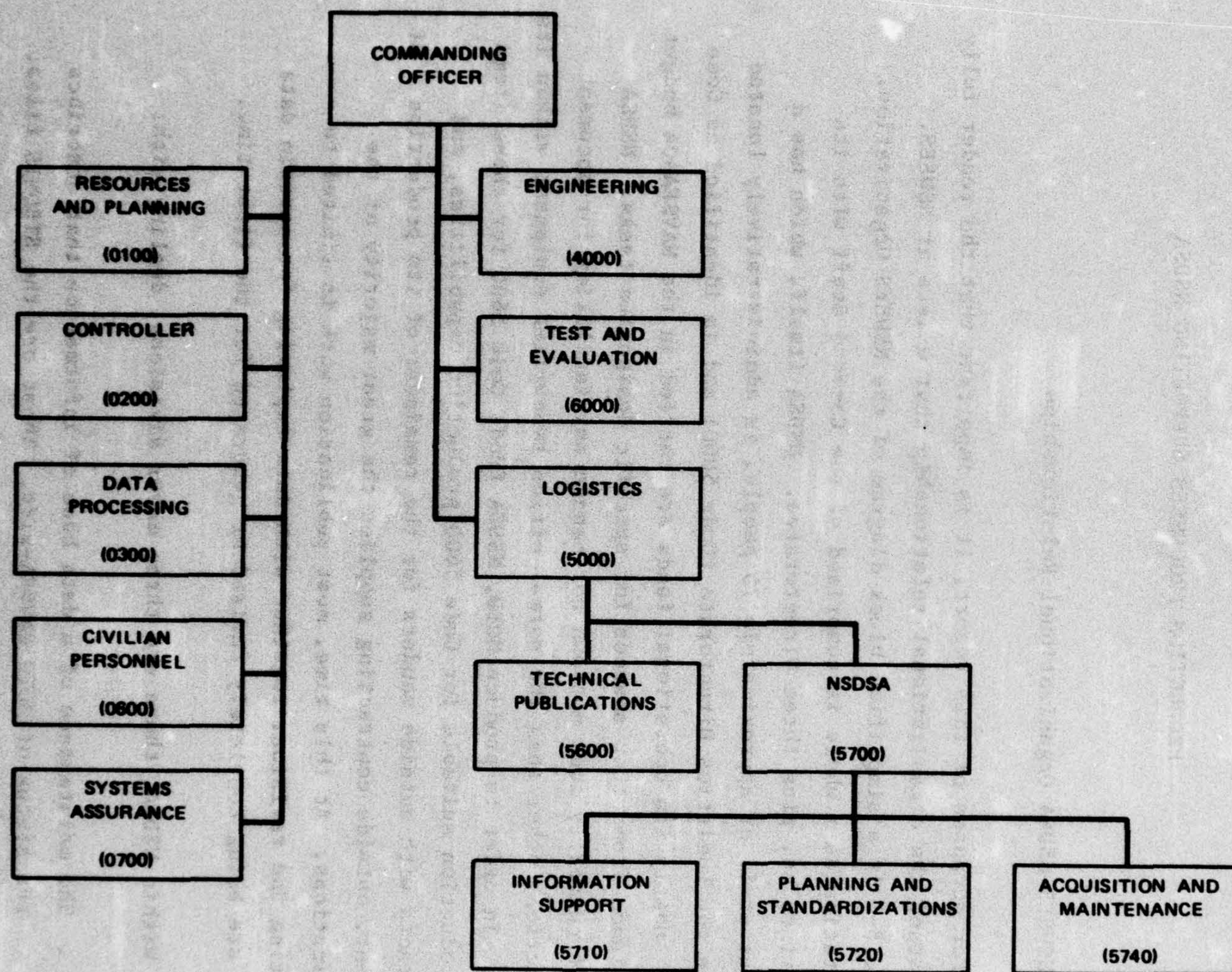

FIGURE B-1 SIMPLIFIED NSWSES ORGANIZATIONAL DIAGRAM

provide the information to produce the TDIs and PRLs, for example, which list the complete set of TMs and other technical data relating to each individual ship. These files enable NAVSEA and NSDSA to determine the status of any technical document through its entire cycle, from authorization to withdrawal.

- Planning and standardization of TM content and format. Since there are currently more than 150 applicable Navy standards that pertain to the preparation, contents, use and maintenance of MOTD, it is easy to understand the importance of this work. One recent product of NSDSA was a new reference document for production and content standards. The new document, while not replacing any specific existing document, will greatly simplify the determination of the appropriate standards to be observed for future MOTD.

- Acquisition of new MOTD and maintenance of existing MOTD for NAVSEA installations. This work begins with the definition of the MOTD requirements for a new installation, whether it is a complete ship or a new piece of equipment and extends to defining and managing the correction of MOTD deficiencies. This division of NSDSA has the responsibility to actually manage the production of MOTD, be it at NSWSES or by contractors. A complete description of this process will be found in Appendix C.

At the time of preparation of this report, the organization of NSDSA described above was being reviewed, in light of newly defined responsibilities and it may be changed by the time this report is published. All of the functions described above will continue to be carried out.

In-House Support

a. Technical Publications Department (Code 5600)

Under Code 5600, Code 5620 operates the ADPREPS equipment at NSWSES. At the time the data were gathered for this report, the equipment consisted of:

- APS-4 photocomposer.
- VDTs (Hazeltine) with Sykes cassette recorders for capturing raw data.
- VDTs (CDC) and associated printers, with expanded capabilities for editing.
- Set of photo film and paper processing equipment.

By the end of the data gathering phase, the Hazeltine VDTs were being replaced with CDC terminals, to provide full upper and lower case capability at all VDTs. An ITEK camera, Model 440 BLSH, was also being prepared for installation, to be used for the production of mat positives.

In order for ADPREPS to operate, other equipment not under the control of Code 5620 is used. This will be described under following sections.

Depending upon the number of vacancies in the authorized manning schedule, Code 5620 has somewhere between 8 and 11 people dedicated to the use of the ADPREPS. (These personnel are located in Code 5623, Composition Branch. The entire Code 5600 has approximately 80 people.)

In addition to operation of ADPREPS, Code 5600 performs many other duties connected with the printing and publishing of MOTD at NSWSES. It also acts as the liaison agency with the local NPPSO for all hard-copy printing requirements for NSWSES, including NSDSA. Code 5600 provides writers, editors, illustrators, and draftsmen to support the preparation of TMs, MIPS, MRCs and other documents.

b. Data Processing Department (Code 0300)

Under Code 0300, the ADP Planning and Operation Division (Code 0310) provides NSWSES with supporting services for computer programming, system specification, and the operation of interface and computer communications equipment. Code 0310 provides Code 5620 with one full-time programmer to satisfy the needs of 5620 for daily operation of ADPREPS and to make necessary software modifications.

To support MOTD production at NSWSES, Code 0310 operates equipment that allows proper communication with outside computers. It operates:

- 1 Comp 18, used as a cassette-to-Univac 9-track computer tape converter, and for other tape conversions.

- 1 Univac 9300, used for Remote Job Entry with a magnetic tape and line printer.

- VDTs for access to the FACSO IBM 370 computer, the FLTAC Univac 1108 and other remotely located computer centers.

- Modems and multiplexers used in conjunction with 9600 baud communications lines to the FLTAC Univac 1108 and the FACSO IBM 370, and other lines and modems to other remote computer centers.

Code 0310 has also had the major responsibility for providing technical support to Code 5620 in the preparation of specifications for a stand-alone dedicated system to replace ADPREPS.

c. Naval Facilities Engineering Command System Office (FACSO)

FACSO at Port Hueneme maintains and operates an IBM 370/165 computer that it makes available to NSWSES. This is a very large computer having 3 megabytes of core, 32 tape drives, 32 disk drives, 10 printers, and it supports a large number of VDT and other terminals. As indicated before, VDTs operated by Code 0300 are connected to this computer to support on-line access. In addition, batch requests for file maintenance, reports and summaries can also be accomodated. The files described above for Code 5100 are maintained on this computer, and it also produces the report printouts and tapes. Further, as will be noted below, the IBM 370 is used to produce magnetic tapes containing information from other Naval Ordnance Stations. These tapes are used to drive the APS-4, to produce OP and ORDALT publications.

3. External Support

a. Naval Fleet Analysis Center (FLTAC)

FLTAC at Corona, California, operates a large Univac 1108 computer as a part of its facility. A text editing system and a text formatting and composition system with the acronym UNADS are resident on the 1108. It is this software that is used by Code 5600 to edit MOTD files, and to order the preparation of APS-4 compatible data and instruction files that are written to magnetic tape, copies of which are transmitted to Code 0300 via the RJE. The connection to this computer from Code 0300 is by a dedicated 9600 baud landline, which is used to provide a 4800 baud connection for the RJE, and multiple 300 baud connections for the VDTs to the 1108, through the use of multiplexing.

b. Naval Publications and Printing Service (NPPS)

NPPS maintains a local office with a printing and microfiche production facility at Port Hueneme and a larger printing and publication facility in Point Magu, approximately six miles away. The local NPPSO accepts raw data and CRC and either prints the required documents (from CRC) or arranges for outside composition, printing, and binding by contractors. Liaison with NPPSO is maintained by Code 5600 for those items of CRC that are produced on the APS-4. Code 5700 deals directly with NPPSO for MOTD microfiche publication requirements.

c. Contractors

Code 5700 deals with numerous contractors all over the United States in its role as coordinator for the acquisition of MOTD for NAVSEA. The contractors either have the responsibility for providing the equipment for which the MOTD is required, have overall contractual responsibility for the performance of subcontractors under their direction, or are tasked with the preparation of MOTD for equipment already in inventory.

The submission of MOTD to Code 5700 can take various forms, formats, and levels of quality. For the entry of data into the ADPREPS, a smoothing process may take place to put the data into a standard format. This usually means retyping the data into single column, double spaced format. NSWSES has a work order arrangement with a local contractor, Sysdyne Corporation, whereby this typing can be done on a cost-per-page basis when similar services are not available at NSWSES.

In addition, COMARCO Corporation has an open GPO work order type of contract, administered through the local NPPSO that permits it to keyboard data and to compose it using an automated system, or to prepare CRC manually. COMARCO operates an HP-2000 computer and other peripherals, together with Beehive VDTs, to compose textual material and

to produce magnetic tape, used to drive their Dymographic Star 191 photocomposer in the production of CRC.

Appendix C

TYPICAL PRODUCTION CYCLE OF NAVSEA MOTD AT THE NSDSA

Appendix C

TYPICAL PRODUCTION CYCLE OF NAVSEA MOTD AT THE NSDSA

1. Background

This appendix examines a typical processing cycle for NAVSEA MOTD document production. Since various aspects of this process involve different organizations within NAVSEA, and often one or more outside contractors, the segmentation of this process tends to be along organization lines which are aligned with functional roles or facility control. As discussed earlier, the information flow and task segmentation is more complex than necessary, because of organizational partitioning of responsibility and the geographical separation, both on and off base, of the necessary equipment.

The production cycle spans several distinct phases, which will be examined separately:

- Initiation of a TM revision cycle
  - Determination that a revision is required
  - Authorization for the revision
  - Contracting out the revision work
- Generation of camera ready copy (CRC) for the revised TM
  - Review of revisions
  - Preparation of revised text
  - Production of illustrations
  - Composition of final document
  - Approval of composed material

. Publication and distribution

- Printing of document
- Generation of microfiche
- Archiving of revision copy
- Preparation of distribution list
- Distribution

2. CRC Preparation

For the phase dealing with the preparation of camera ready copy, two basic approaches are currently followed. The conventional approach is to contract out the work to qualified contractors, available through the organization responsible for the revision changes. The two contractors heavily used by the NSDSA presently are Stanwick and Vitro Labs. Alternatively, if the work can be accomodated, NSDSA prefers to do the CRC preparation on station at Code 5600. They can then directly monitor the work, maintain tighter control throughout the preparation cycle, more readily make modifications in the document, and obtain a machine-readable data base.

The latter course offers many advantages to NSDSA, in particular by facilitating future changes and revisions. The facility in Code 5600 is currently undergoing an expansion and upgrading, and NSDSA hopes to be able to cycle much larger portions of their work through this facility in the future.

Only the NSTM volumes, consisting of ninty-six chapters, are now being produced at NSWSES for NSDSA. It is likely that other documents will be designated for production on that facility. Although the current throughput is limited, it is worthwhile to examine the production cycle of a document through that facility to highlight the reasons for the low volume of throughput and to provide a base for improvement of information flow in an upgraded system. This discussion will also indicate the close control that would ideally be possible in a

true production-level, base-resident system. Monitoring the document though its various stages of production can assure a higher quality product, and make desired modifications or reorganizations possible midway through the production phase, at points which are less costly than later in the cycle.

The focal point of the NSWSES document production facility, as discussed earlier, is a phototypesetter, the APS-4, capable of generating CRC at the rate of 300 pages per hour. Actual throughput is much lower, because of limitations imposed by supportive equipment, remote communications interfaces, interorganization channels and the physical separation of critical components on the base. A representative flow diagram for the production of a typical document through the facility will be examined later in depth. This will highlight the compelling limitations. It will also illustrate one component of a major activity of the NSDSA, namely a CRC preparation cycle for the maintenance of existing MOTD for NAVSEA installations.

3. MOTD Life Cycles

In order to track the activities and responsibilities of the NSDSA, it would be useful to look briefly at the life cycle of MOTD. The NSDSA plays a central role in tracing this history since it maintains the Ship Technical Data Management Information System (STEDMIS) data base, as well as having responsibility for preparing NAVSEA MOTD. This data base contains information on technical documents, the equipment to which they relate, and the ships in the fleet which are supplied with these MOTD. It is used to generate TDIs and PRLs identifying manuals relating to a ship, based on its equipment configuration.

We will look at an overview of the several data bases describing the fleet, the equipment and its location, and MOTD relevant to this equipment. Appendix A describes more fully the life cycle both of the equipment and the document produced. MOTD is maintained on equipment in

the fleet. Currently two different data bases are maintained which enable tracking both the equipment and related TMs. The first is the Ships Equipment Configuration Accounting System (SECAS) consists of several files which track the ships in the fleet, the configuration of systems and equipment in each ship, and the individual equipment codes and equipment status. NAVSEA Code 042 has responsibility for these files, which track the configuration status of a ship out of the shipyard and throughout its lifetime. The files are used to generate ship inventory lists, which are composites of ships' configurations containing specific equipment codes. These files are located at sites indicated in Table C-1, and a few key data elements contained in the Master Ordnance Configuration Report are indicated in Table C-2.

The complementary data base, STEDMIS, relates TMs to equipment in use in the fleet, and to engineering drawings and installation-control drawings. Information pertaining to electronics and ordnance data aboard ship are not tracked in STEDMIS but are contained in the SECAS files.

STEDMIS, maintained on the FACSO IBM 370/165, consists of three primary files:

- Document master file
- Equipment master file
- Ships master file

The STEPS data base, currently under development by the NSDSA, structures the data maintained in the STEDMIS file and expands it to incorporate ordnance information. It is designed to integrate more complete, better organized, and more consistent data than STEDMIS, pertaining to TMs and to the equipment and systems which they describe. STEPS will have a master equipment file and a document master file.

TABLE C-1

SECAS DATA FILES

SECAS-Ordnance	Naval Weapons Station Concord, California
SECAS-Electronics	Naval Sea Support Center Norfolk, Virginia (Atlantic) San Diego, California (Pacific)
SECAS-HME	Ships Parts Control Center Mechanicsburg, Pennsylvania

TABLE C-2

MASTER ORDNANCE CONFIGURATION REPORT DATA ELEMENTS

Header: Class of Ship, Hull, Ships Name, Control Number
Record Items:

- Equipment group code
- Nomenclature
- Equipment work identifier
- Modification level
- Serial number
- DCI

The Ship File will be expanded to include

- Change status
- SAL
- Manufacturer (of ship)
- Equipment index
- Overhaul status

The Equipment File will contain

- Equipment designation ID
- Equipment
- Type of equipment
- Equipment ID
- Manuals for equipment document file
- Document number
- Responsible activity
- Security classification
- Last date of update
- Revision designation

A related file currently contained in the STEPS data base, used to generate the NAVSEA Status Report, is called the Deficiency File. It tracks such document characteristics as number of pages and illustrations. This file contains information on TMs for equipment that is in service, but out of production.

The cognizant technical activities are those assigned responsibility for the equipment updates and, generally, responsibility for the related MOTD. In some cases, all or a portion of the responsibility for MOTD may be assigned elsewhere. For example, management responsibility for technical publications for the LM-2500 Gas Turbine and the Mark 104 Generator Set has been assigned to the NSDSA even though equipment responsibility is retained by the cognizant technical activity. In these cases, the cognizant technical activity funds the NSDSA for changes in MOTD necessitated by equipment changes.

4. MOTD Change and Revision Processes (Refer to Figure C-1)

a. Initiation of Changes

The general principle is that the appropriation which funds an equipment change will also fund related changes to the MOTD. However, there is a large backlog of technical publications in inventory which require change or revision for reasons other than current equipment change. The reasons include an accumulation of equipment changes for which the MOTD was not updated, poor technical coverage in the original publication, poor readability, or nonspecification format. The NSDSA enters these publications into the NAVSEA Technical Publications Update program and establishes priorities for corrections. The inputs for this program may come to the NSDSA from various sources, such as fleet feedback reports, or from the cognizant technical activity. In all cases the information is validated by the cognizant technical activity before it goes into the update program.

SEA(046) provides funds to the NSDSA on an annual basis for the correction of the deficiencies entered in the update program. Currently the two contractors mentioned above, Stanwick and Vitro, are available to NSDSA for the production of engineering data packages and technical manual changes or revisions. Contracts provide for production through manuscript copy only. Composition for printing may be done within NSWSES by the Technical Publications Department, using either conventional equipment or ADPREPS, by the Secretarial Support Branch, or it may be contracted out through the Navy Publications and Printing Service. A large part of the composition which is presently done outside of ADPREPS is potential workload for ADPREPS.

Deficiencies in MOTD are also corrected by the issuance of project orders to the cognizant technical activity, who may do the work in-house, or under local contractual arrangements. Depending on the circumstances, the NSDSA may issue project orders requiring the entire corrective action to be done by the cognizant technical activity, or may only require the technical activity to prepare an engineering data package, with authorization to the contract with one of the NSDSA contractors for the balance of the work.

It is a long-term intention to centralize production under the update program as much as possible, in order to standardize production and presentation techniques, maintain uniform high quality, and to build a data base in the automated composition system.

The normal procedure for processing material through the current NSWSES automated facility is shown in Figure C-1. A technical manual requiring revision is submitted to the NSDSA via the PCC for processing through this facility. The following steps then occur.

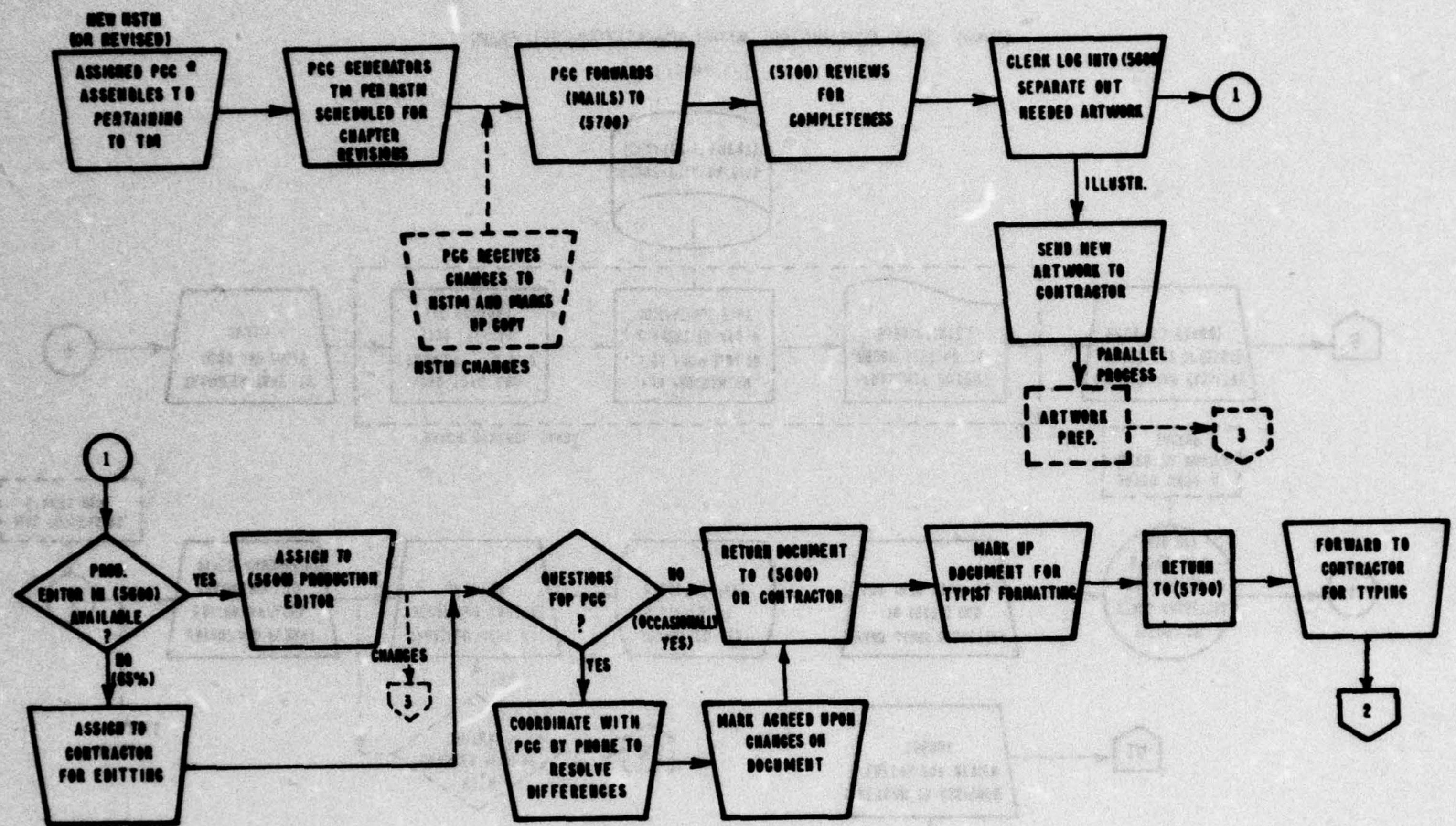

FIGURE C-1

NAVSEA (TTD) PRODUCTION FLOW PROCESS INVOLVING NSDSA-NSHSES

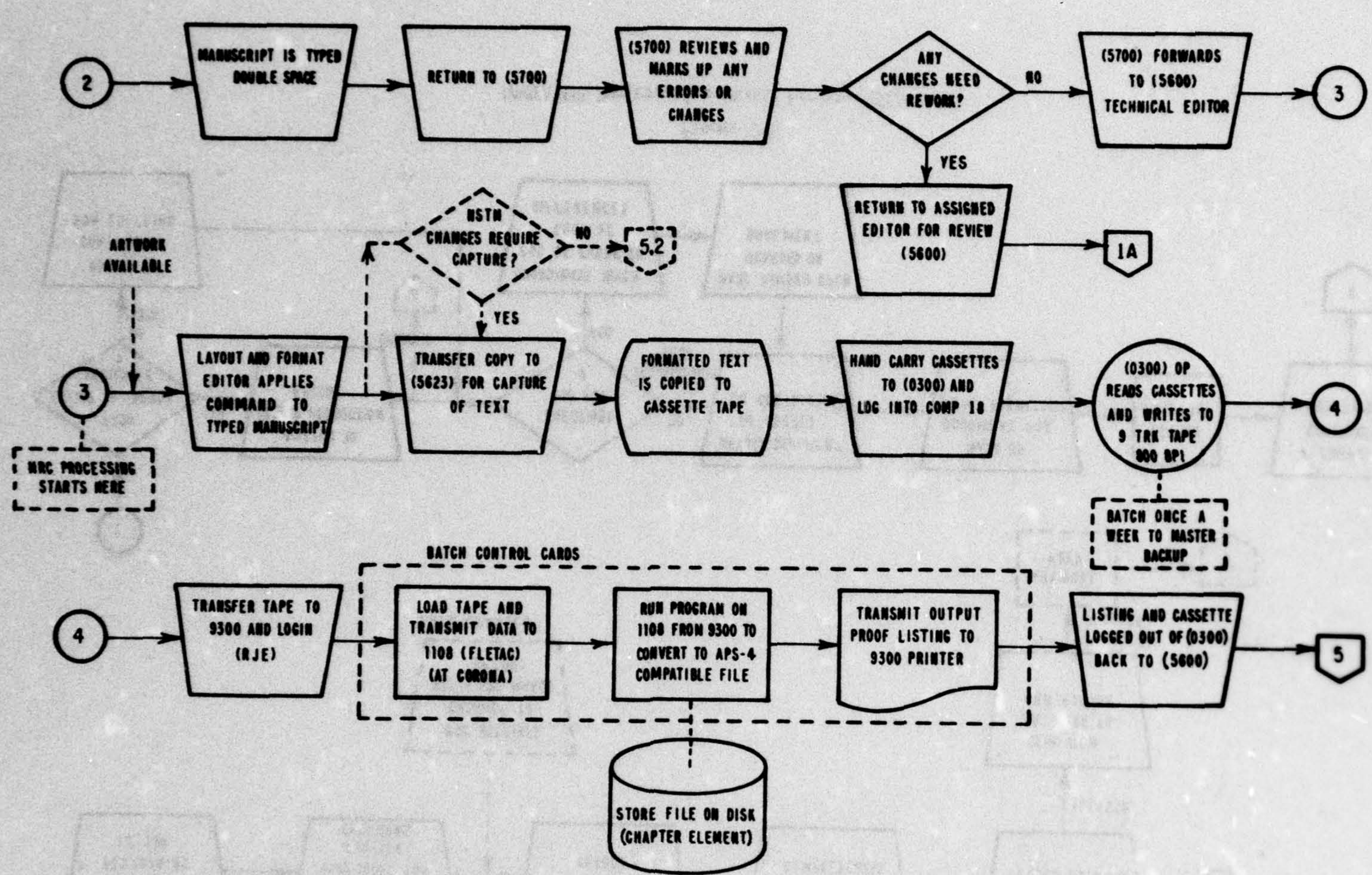

FIGURE C-1

NAVSEA MOTD PRODUCTION FLOW PROCESS INVOLVING NSDSA-NSMSES (CONT.)

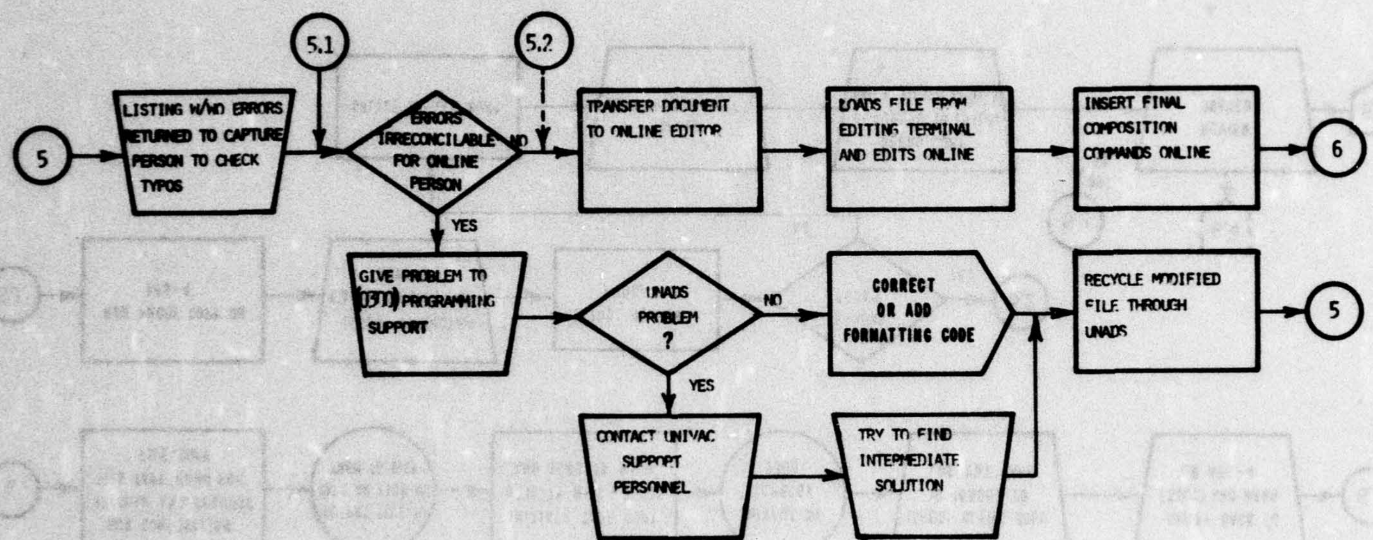

FIGURE C-1

NAVSEA MOTD PRODUCTION FLOW PROCESS INVOLVING NSDSA-NSMSES (CONT.)

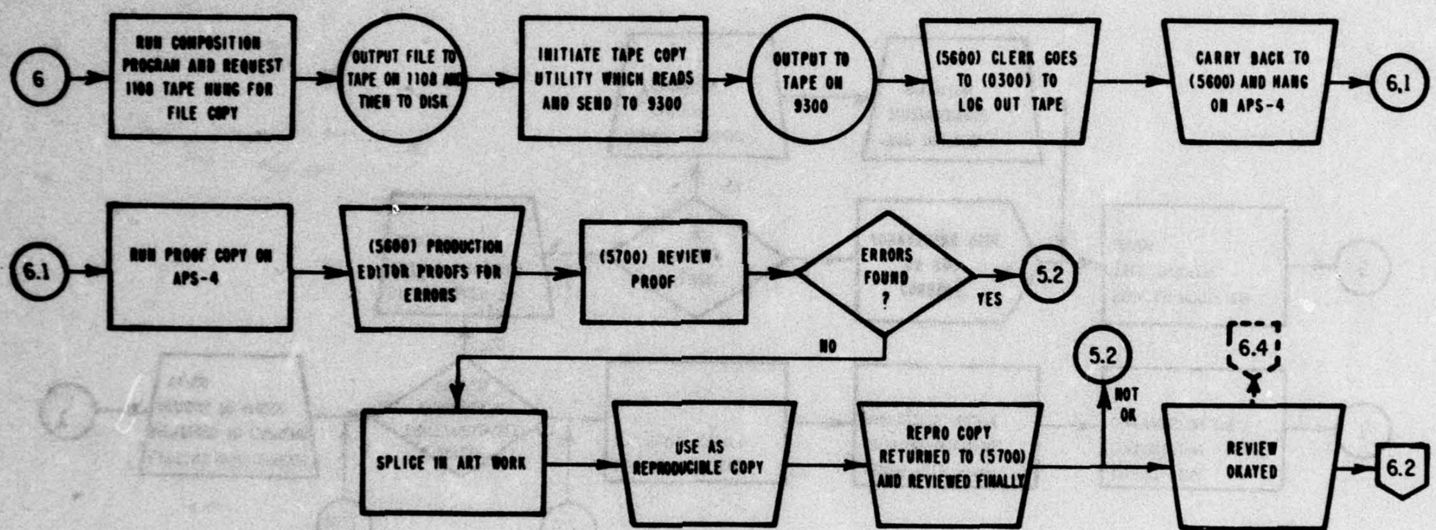

FIGURE C-1

NAVSEA MOTD PRODUCTION FLOW PROCESS INVOLVING NSDSA-NSSES (CONT.)

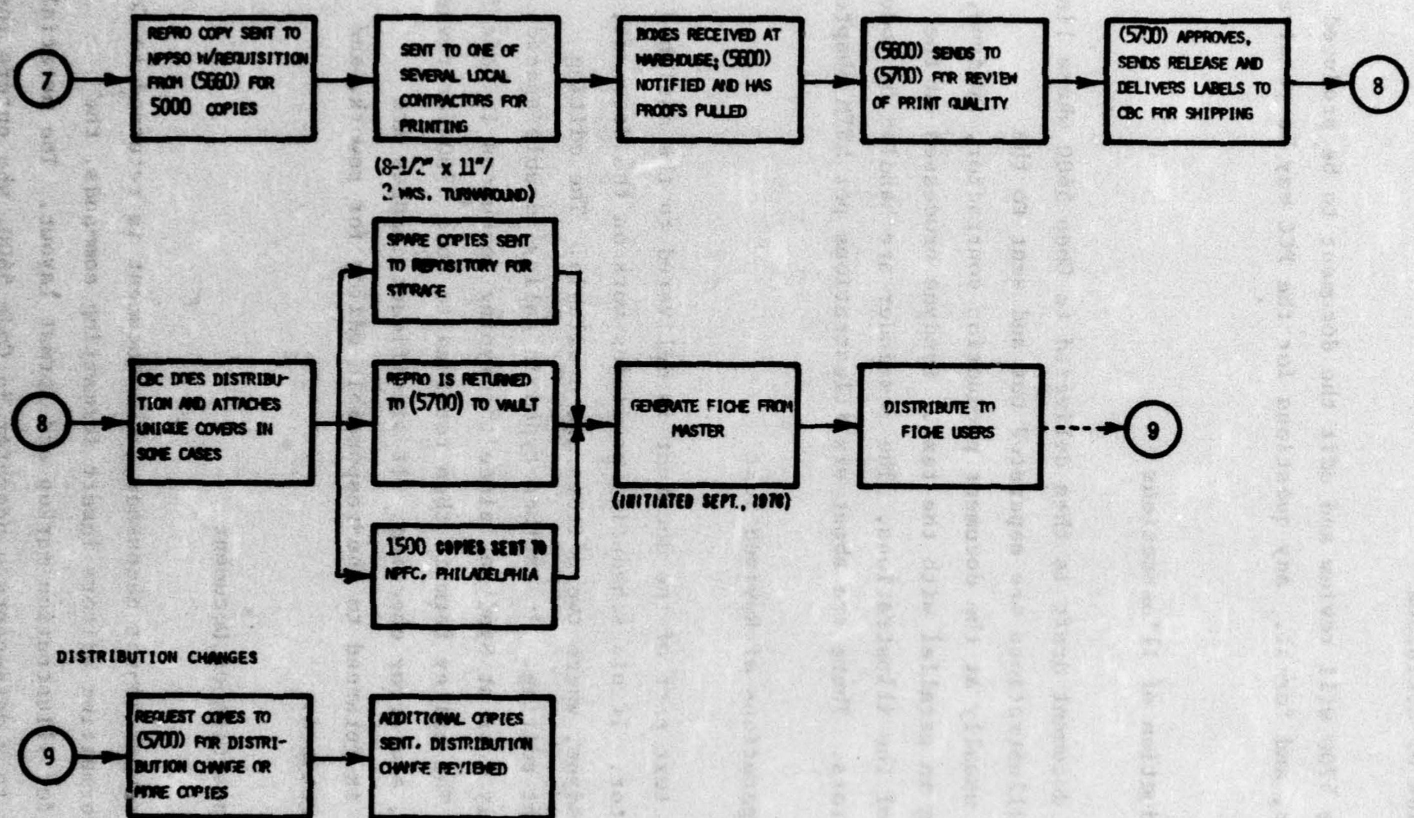

FIGURE C-1

NAVSEA MOTD PRODUCTION FLOW PROCESS INVOLVING NSDSA-NSWSES (CONT.)

b. Review of Revisions

Code 5700 will review and edit the document to be produced for style, grammar, and format. Any questions for the PCC may be resolved by phone.

c. Production of Illustrations

The document draft is then delivered to Code 5600 where line drawings and illustrations are separated out and sent to the illustrators, usually at the document production contractor, Sysdyne, for processing in parallel with the text. Sysdyne processes on the order of 85% of the illustrations. The remainder are handled by Code 5600 illustrators. There are about six illustrations per NSTM chapter.

d. Preparations of Revised Text

The text part of the document is delivered to the assigned Code 5600 Editor. If his scheduling precludes work on the document, it is sent to Sysdyne, where two editors are available. The editing includes format editing. It is then typed in galley, double spaced. This is usually done at Sysdyne, since the typing resources in Code 5600 are limited. The galley form is then returned to Code 5700 for review, change markup, and error checking. If significant changes are indicated, it is returned to the responsible editor for rework, and portions are retyped.

e. Composition of Document

If rework is not necesssary, the document is returned to Code 5600, where formatting editors insert formatting commands, the instructions for illustration markup and format layout. The material is then assigned to a data-capture operator in Code 5600, who enters the material from one of the CRT keyboards onto a cassette tape via the

attached Sykes recorders. This procedure is off-line and no computer is involved. If a document is large, it may be split up among several operators. This initial capture phase includes little or no editing of the text.

When enough cassette tapes are prepared, they are hand carried over to Code 0300, where they are logged. A Code 0300 operator reads them into a stand-alone system, the Comp 18, which copies the cassette tape to a 9-track tape for input into UNADS. This latter tape is then carried to the 9300 RJE terminal, where it is logged in, read, and transmitted to the FLTAC Univac 1108 at Corona. A deck of batch control cards are read at the RJE, initiating a program that transforms the text into a UNADS compatible file. The file is then output as a proof copy in list format on the 9300 printer. The files are stored in a special disk file in units corresponding to data capture work units.

The printout as well as the original cassettes are logged out and carried back to Code 5600, where they are returned to the operator(s) responsible for capture, who proof the documents for typing errors and checks the formatting commands. The material is then given to an edit operator, who accesses the file and works on-line at an edit display terminal to correct any errors. It is also examined for irreconcilable errors, such as non-programmed characters or format characteristics not handled in the present system. Any such unsatisfied capabilities become the responsibility of the programming support staff supplied to Code 5600 by Code 0300; they determine whether programming changes are required at the facility, in UNADS by the Univac personnel, or on contract by Autologic. If Univac support is required, it is supplied by Univac, although not always in a timely fashion. While Univac officially supports the UNADS software package, all problems are placed in a request queue. Sometimes the document can continue to be processed while these problems are pursued.

When the correcting operation is complete, the Code 5600 operator requests that a composed and formatted file be created on the Univac 1108. The operator then calls Code 0300 and requests that a 9-track tape be prepared from this file for the APS-4.

A clerk is sent from Code 5600 to log out the 9-track tape from the Univac 9300 and hand-carry it back to the APS-4. The tape is read into the APS-4 and a proof copy is generated. A Code 5600 edit operator then proofs this copy for errors, and edits all corrections on-line, using one of the edit display terminals. If no errors are found, the document is ready for reproducible copy processing. However, corrections are usually needed. The document is then processed through a similar cycle, is output to a tape at the Univac 9300, and is hand-carried back to the APS-4, where reproducible copy is again generated. This process is repeated until the copy is errorfree, at which point the tables and illustrations, by this time back from the contractor, are spliced into the text. This final copy is then forwarded to Code 5700 and processing is resumed from step 6.2 in Figure C-1. If the copy is found to be acceptable, the original is copied, and a sign-off sheet is attached to the copy.

This copy is then forwarded to Hyattsville to the PCC for signature. The PCC reviews the document, marks any technical corrections, and usually signs. If the PCC does not sign, the document is returned to Code 5700 for correction and recycling. When it is approved, the document is forwarded to NAVSEA Code 046, which is responsible for the NSTM. Here it is usually approved, but documents found to be deficient (about 7%) or poorly presented (perhaps 10 %) are returned to the PCC to rework and to incorporate any corrections. The document then returned to NAVSEA Code 046 for approval, after which it is returned to Code 5700. Any indicated corrections are then processed as before by Code 5600 from the edit terminal stage (step 5.2). When

all modifications have been incorporated to the satisfaction of Code 5700, the reproducible document is forwarded to Code 5600 with a print requisition.

5. MOTD Distribution

In the meantime, Code 5700 determines the appropriate distribution set, creates a new distribution list on the FACSO computer, if necessary, and requests that a set of address labels be generated on FACSO. This takes place as described below.

The Standard Navy Distribution List (SNDL) contains all Navy activity addresses, plus Marine and Coast Guard addresses. The CNO is responsible for maintenance of the SNDL. Various tailored document distribution files are maintained at Port Hueneme, California, Louisville, Kentucky, and Crane, Indiana. These files maintain information by activities, a second set of files contain the chapter/copies/activities/unit/SNDL identification codes.

Code 5700 is currently responsible for NSTM distribution lists. It maintains a hard copy of the SNDL and a cross index file, as well as a hard copy log of each NSTM chapter's distribution. It also handles distribution of selected ordnance publications and anticipates the increase of the distribution list to include all NAVSEA TM document distribution. Code 5700 also generates loading forms for a distribution list or an update, and forwards these to Code 0300. Code 0300 performs the update, gets the key punching done, and requests the generation of a set of labels on the FASCO computer. When the labels have been printed, they are forwarded to Code 5600.

Code 5620 submits the NSTM chapter repro copy to NPPSO for preparation of 5000 copies. It is sent from there to one of the local contractors for printing, which usually takes approximately two weeks. The 5000 copies are received at the CBC warehouse on base, and Code 5600

is notified. The proof copies are pulled and sent by Code 5600 to Code 5700, for review of print quality. Code 5700 then approves, if acceptable, and forwards the release form as well as the address labels to CBC, where the mailroom is located, for shipping.

CBC performs the distribution, in some cases attaching special covers to the NSTM chapter documents. Then several operations take place simultaneously. 1500 copies of the NSTM chapter are sent to NPFC in Philadelphia, Pennsylvania; the repro copy it returned to Code 5700 for storage in the vault; and spare copies from the printing are sent to the NSWSES repository for storage. This completes the immediate NSTM chapter production cycle.

6. MOTD Microfiche Generation

At a later point, microfiche must be generated for distribution to users requesting the documents in that form. This cycle was initiated in September, 1976. The generated fiche are distributed to the approximately 300 users who have requested the NSTM in this form.

Periodically, requests are also received by Code 5700 for additions to the chapter distribution list or for a change in the number of copies. If they are appropriately authorized, additional copies are sent, the SNDL change is reviewed, and later the SNDL is modified in conformance with the request.

Extra copies or changes in the distribution list are received in the form of requests which are processed by Code 5700 first, and then are forwarded to NPFC for distribution. The file containing the distribution lists was generated by a questionaire to those on the former list, to determine if they wish to remain on the list, how many copies they wished to receive, and in what form (hard copy, fiche). They were

also asked the chapter numbers of the NSTM and the distribution list in the form of a five digit code. A similar procedure may be necessary for other MOTD documents for which a distribution list must be generated.

It should be noted that the above description tracks the processing steps that must be taken to produce an NSTM chapter. The time required for each step clearly varies widely. However, what is not reflected is the frequent perturbations encountered in the execution of some steps caused by a number of events out of the control of Code 5600 and Code 0300. Discussion of these events will be found in Appendix D.

Appendix D

CURRENT MOTD PUBLICATION PRODUCTION PERFORMANCE AND COST FACTORS

Appendix D

CURRENT MOTD PUBLICATION PRODUCTION PERFORMANCE AND COST FACTORS

1. ADPREPS Production Responsibilities

The current ADPREPS installation has been in a continuous production mode for a little over one year, during which the final debugging of the system was also taking place. The system is designed to produce CRC from keyboarded data, through a series of media translations using the services of a remote large digital computer, and text editing and composition system software packages. The output device, an Autologic APS-4 phototypesetter, is a very versatile device and, when driven by a properly prepared magnetic tape, can produce a wide assortment of formats and type styles and sizes.

The current products being handled by ADPREPS are:

- Naval Ships' Technical Manual (NSTM)
- Maintenance Index Pages (MIPs)
- Maintenance Requirements Cards (MRCs)
  (See Appendix A for a description of the above items)
- Supply Operations Department Manual (Update only)
- Selected Ordnance Publications

In addition to the above documents, the APS-4 alone is being used to produce CRC from magnetic tapes prepared from files by the FACSO IBM 370 computer. These products are:

- Deficiency Corrective Action Program (DCAP)
- Ordnance Publications-0 (OP-0)
- Ordnance Alterations-00 (ORDALT-00)

It is planned to add the Illustrated Parts Breakdown (IPB) documents to the production list in the near future. It is also intended that new TMs, such as those required for the LM-2500 gas turbine, will be added to the list.

At the present time, production of the NSTM is the single largest occupation of ADPREPS. Because this is so, and because an identifiable product of some uniformity was necessary for obtaining cost figures, the discussions that follow below will, unless otherwise stated, refer to the production of the NSTM, or documents with very similar characteristics, that are also under the purview of NSDSA.

Because of the predominance of the NSTM production, NSDSA is the dominant source of work and funds for ADPREPS. Further, NSDSA has a backlog of publication work that could be placed on ADPREPS, were it not for the limitations of the system. Further yet, the full NSDSA responsibilities, discussed later in this report, make it evident that ADPREPS or its equivalent in all probability could very easily become a captive resource of NSDSA, as a result of production volume alone.

2. Current MOTD Production Methods

Before any discussion of costs can be considered, it is vital that the reader understand the work flow process now used by NSDSA-NSWSES to produce the NSDSA MOTD. Appendix C gives a detailed description of the process itself; it is the intent here to describe the physical flow of data during the process, to make possible an appreciation of the process.

Figure D-1 is an overall block diagram of the work flow process now employed to produce NSDSA MOTD. The first item to note is the

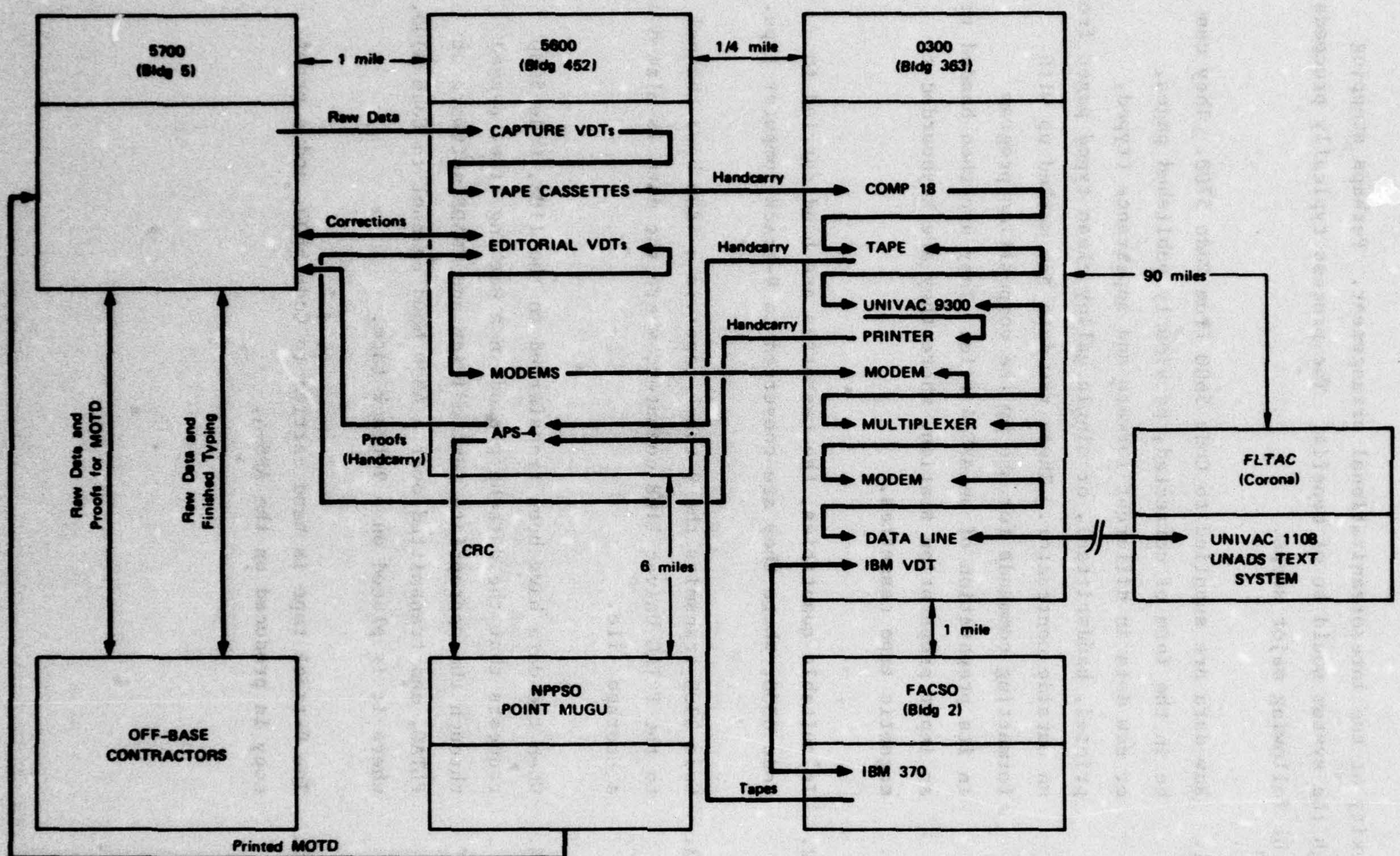

FIGURE D-1 WORK FLOW OF NSDSA PRODUCED MOTD

complexity of the interorganizational arrangement. Perhaps stepping through the system would be of benefit. The process typically proceeds with the following major steps.

Step 1. Raw data are supplied to Code 5600 from Code 5700. They can be in the form of corrected, previously published pages, or new data in different formats and appearance (typed, printed, handwritten), or single galley clean typed pages from an outside contractor. These raw data are marked up with formatting commands for use by the composition program in its preparation of an APS-4 file. They are then handed to an input preparation station, where they are keyboarded to magnetic tape cassettes.

Step 2. In suitable quantities, the cassettes are hand carried to Code 0300, where they are converted to 9-track computer tape.

Step 3. Code 0300 transmits the 9-track tape via a 4800 baud channel to the FLTAC Univac 1108 computer, where the data is placed in a storage file.

Step 4. When the data have been transferred to the 1108, Code 5600 requests that the data be placed in a working file, passed through the appropriate text editing and UNADS software at FLTAC, and transmitted over a 4800 baud channel to Code 0300, where it is placed on a 9-track tape.

Step 5. The 9-track tape is hand carried to Code 5600, and a proof copy is produced on the APS-4.

Step 6. The proof copy is read and annotated. Using VDTs connected through Code 0300 equipment to the FLTAC 1108, Code 5600, using the text editing software, makes the necessary data entries and again requests that a CRC output pass be made on the 1108.

Step 7. The output pass is made and transmitted to Code 0300 as in step 4 above.

Step 8. CRC is produced from the tape on the APS-4.

Step 9. Steps 6, 7, and 8 are repeated as often as is necessary, the desired goal is to avoid any repetition.

Step 10. The CRC is sized and any art work is mounted.

Step 11. Copies of the CRC are hand carried to Code 5700 for review. (This usually involves transmittal to Washington, by mail, with considerable time lapse between the transmittal and the receipt of approval or change requests.)

Step 12. Copies with necessary corrections are hand-carried from Code 5700 to Code 5600.

Step 13. Necessary corrections are incorporated.

Step 14. Finally approved CRC is hand carried to NPPSO for publication.

The reader should note three important aspects of the above process:

- The amount of liaison and physical handling of tapes and copy.
- The multiple conversion processes necessary to produce CRC.
- The storage of the data base at a location approximately 90 miles from the user on a computer not primarily concerned with NSDSA requirements.

3. Current NSDSA-ADPREPS Costs

a. Methodology of Data Gathering

The initial intention was to identify budget line items in order to establish the various cost parameters associated with the production of NSDSA MOTD. It quickly became apparent, however, that this approach would be unproductive, for a number of reasons. Among them are the facts that the actual items of cost, for example the APS-4 costs, are not in an operation budget as such; that quoted personnel costs are dictated by Base personnel policies and do not reflect actual costs; that Code 0300 costs are inextricably interwoven with other operational costs; and Code 5700 costs are not assigned at the level of detail necessary for such an approach. Therefore, a more simplistic approach was taken in the belief that the same results will be derived.

A typical period of time was chosen for which production data was available. Code 5600 has kept easily understood production records for the NSTM, and has also kept records regarding production system assignments and system interruptions and difficulties. With the cooperation of appropriate responsible personnel in Codes 5600 and 5700, a reasonably accurate allocation of labor effort was established for the chosen period and production. It was decided not to include the cost of illustrations, because they are not handled automatically by ADPREPS. However, some representative data for a limited population of illustrations was gathered and will be reported below.

Costs have been arbitrarily divided into fixed and variable categories. The variable costs are for such items as a per-page capture cost, or per-unit storage cost (Univac 1108). The fixed costs are for those items that must be paid for, regardless of use, such as maintenance, communications-connection charges (Univac 1108), and the APS-4.

The costs for production were categorized further into a number of subclassifications, which follow.

Manuscript Preparation -- This item included professional editing of the manuscript contents by the responsible manager at NSDSA at a rate of 10 pages per hour; content and style editing by a professional contract editor at the rate of 10 pages per day; preparation of a clean typed page; and administrative control of the process.

Manuscript Quality Control and Liaison -- This item represents an assigned portion of the responsible Code 5600 editor responsible for proper coordination of the manuscript preparation process and overall quality control of the products.

ADPREPS Data Handling -- The costs under this item represent those associated with input keyboarding, proofing, editing, and correction of the raw data. Various production rates for such functions as entry of APS-4 format instructions into the text, typing, on-line editing and proofing were established. However, since it was also necessary to account for unproductive time, the actual time cards for the personnel involved were examined to obtain the true time charges. A summation of the costs for this item will be given below. Costs were established on the basis of the actual salaries and burdens for the personnel involved.

ADPREPS Administration, Control and System Support --The costs of this item are those normally associated with any production system. They cover a portion of the responsible manager's time, the time of the document control clerk, and the time of the system software expert needed to rectify problems and to implement changes to the system needed because of the refinement of user requirements.

Data Capture-Edit Equipment -- These costs are those associated with the VDTs and cassette tape units used for data entry of the NSTM, and the VDTs and hard copy printers used for editing and proofing. The cost was placed in the variable category, since only those terminals used for NSTM work were included.

Data Preparation and Transmission Equipment -- This item reflects the prorated share of the Comp 18, the Univac 9300 computer, and the communications equipment operated by Code 0300.

APS-4 Equipment and Maintenance -- This item includes the monthly lease cost of the APS-4 and its maintenance, minus the costs for the portion of the available time used to produce OP-0 and DCAP publications. (The total lease cost is $6760 per month.)

FLTAC (Univac 1108) -- These costs represent the connection and data storage costs (fixed) at FLTAC, and the line charges (variable) assigned as a portion of the NSTM processing.

Materials -- Normal items such as paper, film and chemicals, are included in this category.

b. Production Costs

A four-month period, November 1975, through February 1976, was chosen as the sample period. The production logs maintained by Code 5600 are quite detailed, and it was a fairly straightforward determination that during this period 533 pages of finished NSTM CRC were produced. (It should be noted that this does not represent the total number of pages handled by ADPREPS; the number of pages in process varies significantly with time, because of the rather uneven generation of raw MOTD by the authors. The labor costs reflect true costs for NSTM production only.) The costs for NSTM production are summarized in Table D-1, and the labor breakdown for NSTM is given in Table D-2. The

TABLE D-1

SUMMARY OF COSTS FOR NSDSA-ADPREPS PRODUCTION OF NSTM PAGES

(November 1975 through February 1976)

ITEM	Costs (to nearest $10.00)		
	Fixed	Variable	Total
1. Manuscript Preparation		Edit, $17.25/page Type, 3.50/page Control, 2.50/page	$12,390
2. Editorial Quality Control and Liaison		$ 12,000	12,000
3. ADPREPS Data Handling		20,860	20,860
4. ADPREPS Administration Control, and System Support	$6,400		6,400
5. Data Capture-Edit Equipment		8,230	8,230
6. Data Preparation and Transmission Equipment	3,530		3,530
7. APS-4, Lease and Maintenance	22,830		22,830
8, FLTAC (Univac 1108)	2,160	1,000	3,160
9. Materials		450	450
Totals	$34,920	$54,930	$89,850

* For purposes of this report, a page consists of 5000 alphanumeric characters.

TABLE D-2

ADPREPS DATA-HANDLING LABOR, TIME AND COSTS FOR NSTM PRODUCTION

(November 1975 through February 1976)

MONTH (1975-1976)

Personnel	Rate/Hr.	NOV Hours	NOV $	DEC Hours	DEC $	JAN Hours	JAN $	FEB Hours	FEB $
1. GS-5	10.80	121.6	$1,313	33.6	$ 363	151.0	$1,630	45.6	$ 492
2. GS-5	10.05	152.0	$1,527	168.0	$1,688	168.0	$1,688	152.0	$1,527
3. GS-5	10.45	0.0	$ 0	17.0	$ 178	50.4	$ 527	45.6	$ 476
4. GS-3	8.70	0.0	$ 0	17.0	$ 148	34.0	$ 296	45.6	$ 397
5. GS-3	8.70	91.0	$ 792	117.0	$1,018	134.0	$1,166	15.0	$ 130
6. GS-2	8.70	76.0	$ 661	101.0	$ 879	134.0	$1,166	15.0	$ 130
7. GS-2	8.20	0.0	$ 0	0.0	$ 0	126.0	$1,033	15.0	$ 123
Subtotals			$5,805		$4,274		$7,506		$3,275
Total		$20,860							

average cost of $168.57 per page is perhaps low by as much as 15%, since the method used to collect the cost data has limitations. For example, floor space, special power and air conditioning, and similar items were not accounted for because of the difficulty of obtaining such information. It is also highly likely that there are other services provided to NSDSA and Code 5600 by NSWSES that were not detected, although every reasonable effort was made to do so, and complete cooperation was received from all NSWSES personnel involved in the study. Thus, a total cost of close to $200.00 per page, under the conditions then present (the system was in its early production phases) probably represents a realistic upper limit. As will be seen later, this cost is subject to downward adjustment under different volume conditions.

c. Outside Contractor Costs

For purposes of this study, there were two items of cost to be examined for comparison with ADPREPS costs: keyboarding, and complete preparation of CRC. In addition, an attempt was made to identify and quantify the contractor cost of producing illustrations.

There are two standard ways in which keyboarding alone can be contracted, by the hour, or by the page. At the time the data was gathered for this report, the hourly rate was $18.84, and the cost per page was $3.45. This latter cost is referenced to the standard ADPREPS page (5000 alphanumeric characters). It is difficult to completely reconcile these two figures, because when the cost per page is compared to the cost per hour, the production rate appears to be approximately 27,000 keystrokes per hour or approximately 75 words per minute. While this is possible, it is doubtful that this average can be maintained for extended periods, especially when one considers the fact that the material contains editorial instructions. Much industry experience indicates that the upper limit for average sustained production is 20,000 keystrokes per hour, and that rates of 15,000-18,000

are more likely to be experienced. At any rate, it appears that if such services are needed, NSDSA should contract for them at the page rate, since the hourly rate does not guarantee a given production rate.

It should be noted carefully here that outside keyboarding does not result in capture of the data in machine readable form. Hence, no data base is established, whereas data captured within ADPREPS is in machine readable form and is used to establish a data base at FLTAC.

When it comes to production of an entire document by contractor, the cost figures become much more difficult to describe accurately. Exhibit D-1 is a reproduction of a standard costing form used by the NPPSO to estimate costs for producing MOTD by automated production methods. Only one local contractor, COMARCO, is able to supply the types of services listed in Exhibit D-1. COMARCO is described more fully in Appendix B. Using this form to estimate the cost of a single pass of raw text through the system to CRC results in the figures shown in Table D-3, which shows the cost of producing one page of 5000 characters.

While interesting, the figures derived from this type of calculation were of doubtful value. There are too many unknowns left to determine the final actual costs, such as:

- Number of passes necessary for final approved CRC
- Costs for proofing
- Costs for changes
- Costs for pages with nonstandard formats
- Costs for conforming to contractor capabilities
- Costs for delivery delays
- Costs for liaison.

AUTOMATED TEXT COMPOSITION ORDER
11ND-NPPSO-5604/11 (REV. 4-76)

CONTRACT NO.	NPPSO NO.	DATE ORDERED	DATE REQUIRED
N00123-76-C-0840			

PUBLICATION/DOCUMENT TITLE AND DESCRIPTION OF TASK TO BE PERFORMED

ITEM NO.	SERVICES/SUPPLIES	UNITS ESTIMATED	UNITS ACTUAL	UNIT	PRICE	TOTAL
0001	DATA DISPLAY TERMINAL			EA/MO.	$ 208.00	
0002	HARD COPY TERMINAL			EA/MO.	288.00	
0003	CENTRAL TEXT PROCESSING – TIME SHARE					
	EACH MINUTE OVER 79,999			MINUTE	0.209	
	70,000 TO 79,999			MINUTE	0.299	
	60,000 TO 69,999			MINUTE	0.348	
	50,000 TO 59,999			MINUTE	0.419	
	40,000 TO 49,999			MINUTE	0.523	
	30,000 TO 39,999			MINUTE	0.698	
	LESS THAN 30,000			MIN. PER MONTH		
0004	CENTRAL TEXT PROCESSING – DEDICATED			MINUTE	1.13	
0005	STORAGE – ACTIVE (MO. STORAGE/1000 CH)					
	60,000 OR MORE			M/CH	0.157	
	55,000 TO 59,999			M/CH	0.172	
	50,000 TO 54,999			M/CH	0.188	
	45,000 TO 49,999			M/CH	0.209	
	40,000 TO 44,999			M/CH	0.235	
	LESS THAN 40,000			MIN. PER MONTH		
0006	STORAGE – INACTIVE			REEL/MO.	4.19	
0007	MAGNETIC TAPE OUTPUT			REEL	20.00	
0008	HARD COPY OUTPUT			PAGE	0.19	
0009	PHOTOCOMPOSITION OUTPUT – SINGLE COLUMN			M/CH	0.58	
0010	PHOTO COMPOSITION OUTPUT – MULTI COLUMN			M/CH	0.68	
0011	CONTRACTOR KEYBOARDING			MAN/hr.	18.84	
0012	COMMUNICATIONS NETWORK					
0012AA	INTERFACING EQUIPMENT-CONTRACTOR FURNISHED			EA/MO.	1,694.14	
0012AB	INTERFACING EQUIPMENT-CONTRACTOR LEASED			LOT		
0013	SYSTEMS IMPLEMENTATION			MAN/MO.	2,880.00	
0014	KEYBOARDER, INSTRUCTOR			MAN/hr.	13.08	
0015	TRAVEL (NTE 5,000)			LOT		
0016	EQUIPMENT INSTALLATION					
0016AA	HARD COPY TERMINAL			EA.	120.00	
0017	EQUIPMENT REMOVAL (NTE 4,000)			EA.		
0018	EQUIPMENT MAINTENANCE – ABNORMAL					
0018AA	CHARLESTON, S.C. – DATA DISPLAY TERMINAL			EA.	180.00	
0018AB	CHARLESTON, S.C. – HARD COPY TERMINAL			EA/MO	97.88	
0019	DATA			NOT SEPARATELY PRICED		

NPPSO AUTHORIZING SIGNATURE	DATE	APPROVAL/RECEIPT SIGNATURE	DATE	
REQUESTING ACTIVITY	AUTHORIZING SIGNATURE	CONTRACTOR SIGNATURE		$
APPROPRIATION SYMBOL & SUBHEAD	BUREAU CONT & SUB ALLOT NO.	AUTH. ACCTG. ACTIVITY	TYPE	COST CODE
17X4912.2201	46911	62766	2F	0000K002706

EXHIBIT D-1
NPPSO ORDER FORM FOR AUTOMATED TEXT COMPOSITION

TABLE D-3

PER PAGE/PER PASS COST OF CONTRACTOR PREPARED MOTD

USING AUTOMATED METHODS

(Based on 11 Minutes of Keyboarding)

Rental of input terminal	.30
Keyboarding*	3.45
Computer input costs	7.70
Printer proof copy (2 pages)	.38
Entry of composition macros (2 minutes/page) (2/11 of first 3 items above)	2.10
Active storage (1 month)	1.18
Photo composition	3.40
TOTAL	$18.51

*Eleven Minutes at 27,000 Keystrokes per hour.

Experience in the publishing field indicates that the figure of $18.51 per page is low by a factor of at least 3. This also served as a cautionary note that all costs were not included in this estimation process.

There remained one other rather straightforward way of determining actual per-final-page production costs. The responsible manager in Code 5700 was asked for contract and budget figures. These figures give no detail about the unanswered items listed above, but they do give a number that can be used for estimation purposes, since they represent actual costs for services rendered. By this method, it was determined that NSDSA is currently handling MOTD at a rate of approximately 17,000 pages per year. This total consists of approximately 12,000 pages of deficient TM upgrading, and 5000 pages of new TM data acquisition. Of the total, approximately 20% are being processed through ADPREPS; the remainder are produced by outside contractors. It was determined from budget and contract figures that the average cost experienced for the entire 17,000 pages was approximately $195.00 per page.

Since the figure of $195.00 is close to the estimated price of producing pages through ADPREPS, it is tempting to conclude that the cost of producing MOTD is approximately the same, whether done by a contractor or by ADPREPS. At present, however, that is not correct, because the contractor price includes engineering expertise not supplied under ADPREPS services. Perhaps as much as one third of the contractor price is in this category, so that the costs equivalance to ADPREPS services is in the $120.00 to $140.00 range for the contractor.

As mentioned, illustrations costs were not included because of the difficulty in obtaining data. In the main, this results from the wide variety in content of the drawings and the corresponding widely varying preparation and reproduction costs. A review of contracts for

the four-month period in question did result in the information listed in Table D-4. For this small sample, about the only conclusion that can be drawn is that it will be difficult to categorize such costs.

4. Analysis of ADPREPS Operational and Cost Factors

a. General

When ADPREPS was first conceived and introduced, it was a major step forward in providing document production facilities at the NSWSES, and one which has been of benefit to NSWSES and NSDSA. As with any such system, experience is showing that it has shortcomings and no longer represents the state of the art. Operational and procedural as well as technical shortcomings detract from the operation of the system. Immediately following are discussions of the major areas of concern with ADPREPS. It is not easy to isolate any one area, because there is a large degree of interaction between system components. Although the components are discussed item by item, the cause and effect chain represented by the items is complicated and should be borne in mind.

b. Software

The software in ADPREPS is relatively old by text system standards and does not represent state of the art software. The version being used by ADPREPS does not compose pages on-line and does not allow on-line format editing of the text files. All files, when displayed, contain typesetting commands that are intermixed with the data text. Proofing and correction of data text are made more difficult and expensive thereby. The manner in which data are presented to the editors for correction is also clumsy. It requires much more editing time than should be necessary, because there is not a one-to-one correspondence between the hard copy used for proofing and the VDT

TABLE D-4

ILLUSTRATION COSTS FOR SELECTED NSTM CHAPTERS

NSTM Chapter	No. of Chapter Pages	No. of Illustrations	Contract Cost for Illustrations
313	53	9	$ 106.00
422	17	1	57.00
470	55	15	1140.00
634	57	8	83.00
TOTALS	182	33	$1386.00

format presented to the editors. Much experience demonstrates the desired way of operating is in the one-to-one correspondence of all media for any single version of a data set.

From a utilization viewpoint, SRI was informed by ADPREPS personnel that the Univac software presents certain problems. The original programmer who wrote most of the package is available at Univac, and Univac has been very cooperative in responding to requests for assistance, but the process is time consuming. From a practical viewpoint, the situation can be an expensive one for ADPREPS.

c. Procedures and Organization

Only a brief analysis of Figure D-1 is needed to point out the almost tortuous path that data follows in progressing through the ADPREPS system. A first major difficulty is the fact that a computer 90 miles away, which has other much higher priority uses, is being used for file storage and text manipulation. This is further complicated by the fact that Code 0300 is essentially a filter in the process, and filters, by their nature, always introduce delays in systems. Complications are multiplied by the requirement to convert data from hard copy to cassette, to computer magnetic tape, to electrical signals, to computer tape, to computer data; a process that offers many opportunities for introducing data errors and system failures. The fact that the FLTAC 1108 is unavailable from 3 to 10 days at a time whenever Fleet exercises take place, causes a complete halt in any ADPREPS production except of cassettes. Production is further complicated by any unscheduled down time of the 1108 or the unavailability of the 1108 system components, such as the tape transports, either due to failure or reassignment to higher priority tasks. On several occasions during the data gathering phases of this report, the authors had the opportunity to see at first hand examples of the unexpected interruption of services to and from

FLTAC. Problems have also arisen because of the unreliability of the communication line needed because of the distance from NSWSES to FLTAC.

Because of network considerations, ADPREPS cannot handle classified data, a situation which will be quite restrictive when MOTD concerned with classified weapons or propulsion systems are required. Providing secure communications will be technically possible, but operationally unwieldly and expensive.

On the NSWSES level, the distance between the various Codes causes delays and requires otherwise unnecessary liaison duties. Part of these problems could be alleviated by a well designed text handling system: however, location of all parties in close proximity would be of benefit. This is said with the knowledge that building space and occupancy is not an easy problem to solve.

d. Hardware

Reduced to a simple statement, in some parts of ADPREPS there is too little hardware, while in other parts there is too much, mostly as a result of the organizational arrangements and the use of the FLTAC 1108. Referring again to Figure D-1, with a local stand-alone text handling system, at a minimum the equipment beyond the Comp 18 would be unnecessary for ADPREPS. Depending upon the implementation, the need to convert tape cassettes can also be eliminated.

The capture and editing VDTs are reasonable terminals to use with the current system. There are not enough of them to support the output capabilities of the APS-4. The cassette units are state of the art, but their lease costs are very high, compared with the purchase costs of units with similar qualities. They could be replaced by other media, such as floppy discs, at an increase in storage density and data transfer rate and a decrease in cost.

Until after the middle of this project, the photopaper processing unit used in ADPREPS was only tolerable because of the low volume of APS-4 output. (Its usefulness is a tribute to the ingenuity of the Code 5600 staff.) A Versimat Model 11-M was in the process of being installed at this writing. This photopaper processor, with a capactity of up to 25 feet per minute of APS-4 size photopaper, is a very good match for the output capability of the APS-4, since the APS-4 output rate will most likely never exceed 20 feet per minute. The cost of the paper processor is not included in the cost estimates, because its true value is undeterminable at this time. It is a refurbished surplus item from Navy sources. The installation is also in need of a small dark room where paper loading can be done with ease under clean conditions.

The APS-4 is a powerful and versatile photocomposer. In reviewing ADPREPS as an entire system, one comes to the conclusion that the remainder of the hardware is badly underpowered when it is compared to the APS-4. This relationship is discussed in Chapter III of this report.

d. Personnel

On the basis of the equipment available and the procedures that are necessary, the production personnel appear to be representative of those encountered in similar conditions. As usual, turnover is a problem with data entry personnel, they quickly become bored and look for tasks requiring more imagination and skill. In the case of ADPREPS, this means moving up to VDT editing. As a result, for data entry, a 6-hour production day is estimated when production schedules are prepared. At the time of data gathering for this report, two additional persons were needed to insert APS-4 formatting commands into the manuscript text before it is given to a data entry clerk for typing. One additional on-line editor was also needed.

There are two serious personnel deficiencies. The first is the absence of a Branch Supervisor for the ADPREPS branch. This person would be responsible for the scheduling and operation of ADPREPS and any subsequent text handling system. This person would also be responsible immediately for the direct supervision of 12-15 support personnel, with the probability that this number could easily double within the reasonably near future. Attempts to obtain such a person have failed, probably because the position was authorized at a GS-6/7 level when it should probably be at a GS 9 level to be competitive with industry. The second difficulty is that there is only one person able to maintain the software of the current system. This is a serious situation. At a minimum, another technically qualified person should be acquired and trained by the present expert, so that there is backup and overlapping coverage at all times.

Finally, if the system is to handle additional volume, the data entry, format editing, and on-line editing positions will have to be increased in proportion to the additional volume handled. Currently, the limiting factor appears to be data entry staffing. Based on a production rate of 18 pages per day per position, a limit of 54 pages of new text per 8-hour shift now exists. Since the APS-4 can produce over 2,400 pages in the same time period, it is not difficult to identify the potential production bottleneck. Further discussion of this subject is found in Chapter II and Appendix B.

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